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User's Guide to PANCOR: A Panel Method Program for Interference Assessment in Slotted-Wall Wind Tunnels

William B. Kemp, Jr.

ViGYAN, Inc.
Hampton, Virginia

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Summary

Guidelines are presented for use of the computer program PANCOR to assess the interference due to tunnel walls and model support in a slotted wind tunnel test section at subsonic speeds. Input data requirements are described in detail and program output and general program usage are described. The program is written for effective automatic vectorization on a CDC CYBER 200 class vector processing system.

Introduction

PANCOR is a computer program for assessing interference due to tunnel walls and the model support sting at subsonic speeds in slotted-wall wind tunnels. The program is derived from, and uses many elements of STIPPAN, a slotted tunnel interference prediction program described in refs. 1 and 2. These programs utilize a high order panel method technology as developed by Thomas (ref. 3) augmented by special features for representation of slotted-wall tunnel test sections. In PANCOR, use is made of pressures measured on the slotted walls between slots to control the flow through the slots and to determine the velocity entering the test section. One or more additional wall pressures measured just downstream of the slotted region control the velocity entering the solid-wall diffuser. Applications of PANCOR are illustrated in ref. 4.

The input data are organized in four groups, three of which can be saved for use in successive cases and only those data elements most likely to change from one test point to the next in a wind tunnel test program need be read for each case. Printed program output includes interference corrections at the model, consisting of a longitudinal buoyancy correction to drag coefficient and interference increments of Mach number and flow angularity averaged over the wing and over the horizontal tail if one exists. These corrections are evaluated both including and excluding sting interference. Standard printed output also describes the flow properties at the control points used for problem solution and at a set of field points arbitrarily defined by the user. The output properties include the components of tunnel interference perturbation velocity. The interference perturbation is defined as the total perturbation less that induced by the singularities representing the test model. Output data files accessible to computer plotting utilities are also provided.

The present paper presents a description of the types of panel singularities, networks, and boundary conditions provided, gives guidelines for assembling the interference assessment problem from these elements, and describes the input data requirements and output format in detail.

Symbols

B	constant in right hand side of boundary condition
c	wing chord at local spanwise station
C_p	pressure coefficient
d	wall slot spacing
m, n	index of m-line or n-line in panel network
$\vec{n}$	unit normal vector of panel
S	source line strength
t	local wing thickness
t_{TE}	wing thickness at local section trailing edge
u	longitudinal perturbation velocity
$\vec{V}_\infty$	reference velocity vector
$\vec{V}_p$	perturbation velocity vector

x, y, z cartesian coordinates

X_1 x coordinate relative to mid-chord point of local wing section

γ local lifting vorticity on wing or tail

μ doublet strength on panel

σ source sheet strength on panel

$\tilde{\phi}$ perturbation potential in domain exterior to computational tunnel domain

Network, Panel and Boundary Condition Options

Network Properties

Many of the singularity panel networks and boundary conditions used in PANCOR are identical with those described in ref. 2 for the STIPPAN program. For completeness, and because some differences exist in source networks and boundary conditions, the elements used in PANCOR are described herein in detail.

In the basic panel method, the bounding surface of a solution domain is divided into one or more networks, each of which may be subdivided into panels. The geometry of each network is identified with the intersections of a set of m-lines with each of a set of n-lines. The input integers ML and NL define the number of lines in each set and the index m or n identifies a specific member of the set of m-lines or n-lines respectively. Panel corners are located at the line intersections and the boundaries of each single panel are formed by the straight line segments connecting the intersections of two adjacent m-lines with two adjacent n-lines. While the panels are quadrilateral in general, adjacent lines in either set are allowed to merge forming a triangular panel.

Within each network, the ML*NL line intersections (defining points) and the (ML−1)*(NL−1) panels are indexed with the inner index m varying most rapidly. The panel index is used also as the index for other properties uniquely associated with each panel. The corners and edges of each network are also identified in order. The m and n values for each network corner are:

corner	m	n
1	1	1
2	1	NL
3	ML	NL
4	ML	1

and the edges are identified by:

edge	
1	m = 1
2	n = NL
3	m = ML
4	n = 1

A unit normal vector is calculated for each panel as the unit vector in the direction of the cross product of a panel width vector in the n-advancing direction into a panel width vector in the m-advancing direction. The sense of the unit normal vector is sensitive, therefore, to the order in which panel defining point coordinates are read into the network index grid.

Certain properties common to all panels within a network are input as network properties. These include the type and order of singularity distributions over each panel and the form of boundary condition imposed at the control points.

Doublet Networks

The form of doublet strength distribution over each panel is specified for each network by the value of IDT. The options available are given in the following table.

IDT	Order of distribution	Number of unknowns
0	none	
1	constant	(ML−1)*(NL−1)
2	bilinear	(ML−1)*(NL−1)
3	biquadratic	(ML+1)*(NL+1)

Control points (points at which boundary conditions are imposed) are located at the panel center points for all nonzero doublet distributions. For the biquadratic distribution, additional control points are placed at the network corners and along the network edges at panel boundary midpoints. For IDT $>$ 0 the set of unknowns for the network is the set of doublet strengths at control point locations. For IDT $>$ 1, each coefficient of a higher order term in the bilinear or biquadratic equation for the panel singularity distribution is established as a linear combination of the singularity strengths at neighboring control points, the combining coefficients having been determined from a weighted minimization process.

Source Networks

The options available for panel source strength distributions are given in the following table and are selected by the value of IST.

IST	Order of distribution	Number of unknowns	Restrictions
0	none		IDT $>$ 0
1	constant	(ML−1)*(NL−1)[a]	
2	bilinear	(ML−1)*(NL−1)[a]	
6	bilinear	NL−1	ML−1 σ factors specified
9	bilinear + lines	(ML−2)*(NL−2)	IDEFN=0, IDT=0
−1	constant	1 (free)	ML=NL=2, IDT=0 or 1
−2	bilinear	3 (free)	ML=NL=2, IDT=0 or 1

[a]for IDT=0

Values of 1 and 2 provide general purpose source panel networks with the source strength quantified at the panel centers. For IST = 2, the bilinear coefficients are established by the same procedure used for the bilinear doublet distribution. The set of panel center source strengths is the set of unknowns for the network only if IDT = 0 is specified for the same network. If both IDT and IST are greater then zero, the set of unknowns is determined by IDT and the panel center source strengths are calculated from:

$$\sigma = -\vec{V}_\infty \cdot \vec{n} + B \tag{1}$$

where B is a constant entered into the right hand side of the matrix equation and is zero by default unless an option to read a set of B values for the network is selected.

The IST = 6 network is a special bilinear source panel network developed for use in the transition region at the downstream end of wall slots where some slotted-wall tunnels have reentry flaps. Control points are located only at the center of the last panel in each m row; i.e. the panels between m-lines ML−1 and ML. The set of unknowns is the set of source strengths at the centers of these last panels. The source strengths of all other panels are established by use of a set of strength facotrs specified by the user. There are ML−1 such factors and the ratio of the strength of any panel to that of the last panel in the same m-row will be the ratio of the value of the corresponding strength factor to that of the last factor.

A discrete slot representation of the slotted wall is provided by the IST= 9 network. The discrete slots are represented by piecewise linear line source distributions along each n-line except those at network edges 2 and 4 and are quantified at all interior panel corners. The set of unknowns consists of the line source strengths at all interior panel corners. The line source strengths at network edges 1 and 3 are zero by definition. Control points are also located at the interior panel corners. Bilinear panel source distributions are also used but their strengths and gradients are determined by the line source strengths. IDT must be specified as zero but the network must be superimposed on another network having IDT> 0 and having panel boundaries in the slotted wall region which coincide with those in the IST= 9 network.

IST values of -1 and -2 may be used only with a single panel network (ML=NL=2) and offer the means of inplementing special problem closure conditions. The unknowns consist of the one or three coefficients of the constant or bilinear source distribution over the panel. The location and other properties of the one or three control points are free to be established directly by input specifications. If IDT= 1 is specified along with a negative IST, the doublet strength unknown and the panel center control point are appended to the unknowns and control points established by the negative IST.

Boundary Conditions

The types of boundary condition provided are listed in the following table. Although the boundary condition type imposed at each control point is ultimately stored in the array named IBCT, the input specification is in a different form. For each network, the type used for all panel center control points is given as IBCIP, that used at each edge of the network is taken in order from the four input values of IBCEP, and at each corner from the four input values of IBCCP. The boundary condition type for each free boundary point provided by negative IST, and for each redefined control point is input directly into IBCT.

IBCT	Description	Restrictions
0	none	IBCIP, IDT=0, IRHSI=1
1	C_p specified	
3	$\vec{V}_p \cdot \vec{n} = -\vec{V}_\infty \cdot \vec{n} + B$	
4	$\bar{\phi} = 0$	
5	$\mu = 0$ ($\sigma = 0$ if IDT= 0)	
6	slot flux smoothness	IBCEP, IDT=0, see text
12	$\partial\mu/\partial y = 0$	IBCEP or IBCCP, IDT> 0

Boundary condition type 0, if specified as IBCIP, results in the elimination of all control points for the network and provides for the a priori specification of source panel strengths in a network with constant or bilinear source panels. In this case, IDT must be specified as zero.

Boundary condition type 1 provides for specification of pressure coefficient at the control point locations on the positive normal side of the panels. When this boundary condition is used, the solution is updated iteratively to satisfy the exact nonlinear expression for pressure coefficient. Values of prescribed pressure coefficient may be read into the right hand side array B. Alternatively, a feature allowing the control point properties to be redefined may be used. With this feature, the location, boundary condition type, and right hand side constant of any specified control point(s) can be altered from those created from the network properties. This feature is particularly useful for pressure coefficient specification to allow control point locations to coincide with pressure orifice locations.

Boundary condition type 3 provides for the direct specification of the normal component of total velocity (Neumann boundary condition) on the positive normal side of the panel. The constant B (default=0) is the specified value of normal velocity. If IST and IDT are both greater than zero, the same value of B is used in calculating the panel source strength by eqn. (1). The normal component of perturbation velocity on the opposite side of the panel is thereby set to zero regardless of the value of B.

Boundary condition type 4 provides an indirect means of imposing the Neumann condition. The condition imposed directly is that the perturbation potential on the negative normal side of the panel be zero. Again, if IST and IDT are both greater than zero, the source strength calculated by eqn. (1) produces a normal component of total velocity on the positive normal panel surface approximately equal to B.

Boundary condition types 5 and 12 are special conditions imposed directly on local doublet distribution properties rather than on flow properties. Boundary condition type 5 provides a convenient means of constraining the otherwise free constant of integration in the value of potential if all other boundary conditions are imposed on velocity rather than potential. Boundary condition type 12 can be imposed at a doublet network edge lying in a plane of symmetry to improve the solution continuity across the plane of symmetry.

Boundary condition type 6 must be specified as IBCIP. It is provided to suppress an abrupt onset of line source strength S at the beginning of a slot line by requiring that the line source gradient dS/dx is equal on the first two line segments. On an individual source line, it is formulated as

$$\frac{S_1}{x_1 - x_0} - \frac{S_2}{x_2 - x_0} = 0 \tag{2}$$

where the subscripts 0, 1, and 2 denote conditions at the slot intersection with m-lines 1, 2, and 3 respectively in the IST = 9 networks. This boundary condition is not intended for specification on a network with IST = 9, but may be specified in place of local constraints at control points on networks having IST = 1 or 6. If the total number of type 6 constraints is equal to the total number of slots in all IST = 9 networks, eqn. (2) is imposed independently on each slot. Alternatively, if the total number of type 6 constraints is equal to the number of IST = 9 networks, eqn. (2) is summed over all slots in each network. If only one type 6 constraint is specified, eqn. (2) is summed over all slots in all IST = 9 networks. The logic underlying the use of this constraint is discussed in the following section.

All control points, or constraints, are indexed within each network as shown in the following table.

Singularity type	Local index	n-range	m-range
IDT or IST= 1 or 2	(n-1)*(ML−1)+m	n=1,(NL−1)	m=1,(ML−1)
IDT=3	(n-1)*(ML+1)+m	n=1,(NL+1)	m=1,(ML+1)
IST=6	n	n=1,(NL−1)	
IST=9	(n-1)*(ML−2)+m	n=1,(NL−2)	m=1,(ML−2)

The global control point index is formed by adding the index within the local network to the total number of all preceding control points. For this purpose, all control points in networks with boundary condition type 6 are accumulated first, then those in all other networks are accumulated in the order of their definition in the input data file. The order thus established for the global control point index is used later for the order of rows in the matrix equation.

Smoothing

PANCOR provides a capability for altering the primary coefficient matrix to introduce solution smoothing within any multi-panel network. The user may specify smoothing factors in the m- and n-line directions of any such network which causes the solution distribution to be smoothed in the specified direction while allowing some error in satisfying the corresponding boundary conditions. This feature is useful to allow solution of an otherwise divergent problem or to improve the regularity of the solution of an ill-conditioned problem.

Structuring the Assessment Problem

Program PANCOR provides a number of features, or building blocks, which can be linked together to define and then solve a wind-tunnel interference assessment problem. Some of these building blocks were described in the previous section; in this section, their appropriate assembly will be discussed. Although numerous variants are possible, the two variations described herein are those which have received the most emphasis in development of the PANCOR program.

The solution domain, occupying a rectangular parallelepiped, is set up as a fully bounded domain in which the potential flow field represents the equivalent inviscid flow in a portion of a wind tunnel including the test section, a constant area solid walled entrance duct, and the initial part of the solid walled diffuser just downstream of the test section. Outside of this domain, an unperturbed flow is presumed, having a velocity of unit magnitude in the direction of the tunnel axis. This unit velocity is taken as the reference velocity from which perturbations are expressed in both the solution and the outer domains. The solution domain is bounded by networks of doublet panels which permit a potential jump across the boundary. Type 4 boundary conditions are specified with these panels to fix the outer flow in an essentially unperturbed state. The potential in the solution domain is made continuous with that in the outer flow by specifying zero strength of a doublet panel on the upstream face of the solution domain. If this face is sufficiently far upstream of the test section or other sources of disturbance, it may be represented by a one-panel network (NL=ML=2) in which zero doublet strength is achieved by omitting the doublet panel (IDT=0).

Boundary conditions are imposed on the interior flow by superimposing one or more source networks on the boundary doublet networks. If C_p were known over the entire bounding surface, source networks with the type 1 boundary condition could be used to reproduce the tunnel flow. The LINCOR program (ref. 5) presumes that this kind of boundary information is known. Program PANCOR, however, allows mixed boundary conditions, thereby permitting the use of the Neumann condition where the equivalent inviscid normal velocity component at the boundary is known with sufficient accuracy, and requiring the use of measured pressures only as needed to establish flow rates normal to the boundary in those regions where the flow processes are not known with confidence. Neumann conditions are imposed on solid wall regions of the tunnel by specifying boundary condition type 0 for the source panel network and specifying the right hand side constant B at each panel center as the equivalent wall slope. The Neumann condition in regions with zero wall slope can be imposed simply by omitting any source panels in those regions.

Recourse is made to measured pressures to define the flux distribution through the wall slots and through the reentry region at the downstream end of the slots, and the longitudinal velocity perturbation of the flow entering the upstream end of the solution domain. To control the flux distribution through the slots, pressures measured on the flat surfaces between slots are specified in coefficient form. The number of longitudinal rows of such pressures must equal the number of slots. The slotted wall is represented in PANCOR by superimposing the discrete slot source network, IST=9, on the doublet panels in the slotted wall regions. All of the control points in the IST=9 network are then redefined to be located laterally in a measured pressure row, and longitudinally, some fraction of panel length downstream of the corresponding line source quantifying point. The magnitude of the longitudinal control point shift is not critical although solution stability is best if the control points are about one-half panel length downstream of the line source quantifying points.

At the downstream end of the slots, some slotted-wall tunnels have a region of complex geometry involving reentry flaps and possibly a discontinuity in wall contour. It is difficult to state just how such a region should be modelled or just how much use should be made of measured pressures in this region. With PANCOR, it is possible to model such a region with a smooth transition from discrete slot flux to smoothly distributed wall flux. The IST=9 network should extend to the downstream end of the slots but if the next to last m-line is located at the leading edge of the reentry flap (or transition region) the line source strength will decrease linearly from that at the last quantifying point to zero at the slot end. An IST=6 network is then superimposed on this region with the shape of the longitudinal source distribution specified to increase smoothly (perhaps linearly) to that of the downstream panel. Wall pressures measured in the immediate vicinity of the slot ends may be specified with a type 1 boundary condition to control the strengths of the longitudinal rows of panels in the IST=6 network. It is preferable to divide the IST=6 network laterally so that each slot terminates in a different longitudinal row of panels. Care should be exercised, however, to avoid placing a panel boundary very close to a pressure control point.

Figure 1 illustrates the superposition of the several kinds of panel networks used to represent a slotted wall. As illustrated in this figure, large source panels with specified strength may be added to represent regions of constant wall slope. The combination of the IST=9 discrete slot network and a IDT=3 doublet network produces essentially zero normal velocity everywhere on the slotted wall except at the slots themselves, regardless of the slot flux. Thus, the effective slope of a slotted wall may be controlled by adding specified strength source panels just as on a solid wall.

One more property of slotted walls must be recognized in the PANCOR problem formulation, that is, the flow must make a smooth transition from the solid wall nozzle to the slotted wall region without an abrupt onset of flux through the slots. This property, which is not unlike the Kutta condition at an airfoil trailing edge, is demonstrated by the characteristic mode of tunnel/plenum interaction derived in ref. 1. This property may be satisfied in PANCOR by using a type 6 boundary condition to control the source strength of a panel on the upstream face of the solution domain, thereby allowing a longitudinal velocity perturbation to exist in the flow approaching the slot origin to compensate for a difference in definition of the reference pressure used in forming pressure coefficients between the experimental data reduction and the PANCOR computation. On the downstream face, a one-panel network with IDT= 1 and IST= −1 may be used to impose the unperturbed outer flow constraint, bounday condition type 4, on the centers of both the downstream and upstream faces of the computational domain.

In the formulation just described, the slot flux smoothness constraint is imposed only in an average sense over all slots. Minor inaccuracies in the measured wall pressures can cause erratic flux distributions on individual slots. Also, the pressures used to control the IST=6 source strengths must be near the slot terminations at the entrance to the solid wall diffuser. Because of the complex flow phenomena occurring here, it is anticipated that the spacial variation of pressure in this region of the actual tunnel might be large and might be poorly reproduced in the computational flow. Thus, adaptation of this PANCOR formulation to a given tunnel might require careful tailoring of the locations of both the wind tunnel orifices and the PANCOR control points.

An alternative formulation which reduces some of these problems can be used. In this alternative, slot flux smoothness constraints are specified for each control point in the IST=6 networks at the downstream end of the slotted walls. Measured pressures are not used at these points. Instead, a single wall pressure, measured at a location on the solid wall diffuser where the actual and computational pressures might be matched more reliably, is used to control the source panel strength on either the upstream or downstream face of the computational domain. This alternative formulation is illustrated in fig. 1 and is used in the sample case described in Appendix D. It probably is preferable in most cases to that using measured pressures as boundary conditions for the IST=6 networks.

The Input Data File

The input data file is a sequence of card image records. The following subsection entitled Input File Records describes in order all of the record types which are or might be required. The input variables, format, and repetition requirements for each record type are given and the conditional requirements are noted in comments. If the number of records is indicated as a fraction, the fraction should be rounded upward to the next integer.

A following subsection lists the definitions of all input variables in the order encountered in the input file description. Note that record type 1 is read only as the first line of the input file; the value of CASID, if greater than zero, is automatically incremented by unity upon completion of each case. Input for the second and succeeding cases begins with the MOVE array in record type 2. After the first two record types, the input data are divided into four groups, the first three of which may or may not be included depending on the entries in the MOVE array. All groups must be included for the first case of a file, and the MOVE array and the case-dependent group must be included for each case.

The appendices A, B, and C give more detailed descriptions of the MOVE array, the network linkage provision, and the test model representation, respectively. A sample case is described in Appendix D which shows a complete input data file.

Input File Records

Record Type	No. of Records	Format	Variables or comments
1	1	F10.0	CASID – First line only, do not repeat for multiple case input files.
2	1	4I4	MOVE(1-4)
			The panel definition group, record types 3 through 15, is to be included only if MOVE(4)=0.
3	1	2I5,2F10.0	ISYM, NNET, XROT, ZROT
4	NNET	17I4	NL, ML, NLR, IDEFN, IST, IDT, IRHSI, NCPR, IBCIP, IBCEP(1-4), IBCCP(1-4)
5	1	I10,2F10.0	ITMX, CNVU, RFU
6	NNET/8	8F10.0	FSN(I)
7	NNET/8	8F10.0	FSM(I)
			For each network, taken in order from 1 to NNET, include either a group of type 8 through 10 records if IDEFN=0, or the required number of type 11 records if IDEFN=1.
8	1	3I5,F10.0	NDIR, MDIR, NORM, XNO
9	NL/8	8F10.0	XND(I)
10	ML/8	8F10.0	XMD(I)
11	NL*ML	3F10.0	PDEFP(I)
			Include a record type 12 only for each network having IST=6 and IRHSI=0.
12	(ML-1)/8	8F10.0	SFM(I)
			Include the required number of type 13 records for each network having IRHSI=1.
13	(NL-1)* (ML-1)/8	8F10.0	BCENP(I)
			NFBP is total number of free boundary points. Count 1 for each IST= −1 network and 3 for each IST= −2 network.
14	NFBP	2I5,6F10.0	IPOINT, IBCT, PCONP(1-3), SCONP(1-3)
15	NCPR	2I5,3F10.0	ICONP, IBCT, PCONP(1-3)
			The field survey group, record types 16 through 18, is to be included only if MOVE(2)=1.
16	1	3I5	NROW, IDAT, NDAT
			Include the required number of type 17 records only if IDAT>0.
17	NDAT/8	8F10.0	DAT(I)
18	NROW	2I5,6F10.0	IPCH, NPROW, X1, Y1, Z1, X2, Y2, Z2
			The model and sting group, record types 19 through 34, is to be included only if MOVE(3)=1. Note that PANCOR does not provide for model roll attitudes other than the conventional upright attitude. An inverted model (180° roll) may be simulated by reversing the sign of the variables underlined below in record types 20, 21, 23, 27 and 37. If the sting is also inverted, the values of ZSS in record type 32 should also have reversed sign.

19	1	5I5	NBS, NWS, NTS, NSEB, ISEB
20	1	5F10.0	XMROT, ZMROT, DTHET, ZWING, ZTAIL
21	1	5F10.0	XMREF, ZMREF, SREF, CREF, DA2MI
			Include types 22 through 25 only if NBS≥ 2, omitting type 25 if NSEB=0.
22	NBS/8	8F10.0	XBS(I)
23	NBS/8	8F10.0	ZBS(I)
24	(NBS-1)/8	8F10.0	QBV(I)
25	NSEB/8	8F10.0	WKW(I)
			Include types 26 and 27 only if NWS≥2.
26	NWS	7F10.0	YWG, XCW, CW, QS0, QS1, QS2, QS3
27	NWS	8F10.0	QG01, QG11, QG21, QG31, QG02, QG12, QG22, QG32
			Include types 28 and 29 only if NTS≥ 2.
28	NTS	7F10.0	YTS, XCT, CT, QS0T, QS1T, QS2T, QS3T
29	NTS	4F10.0	QG0T, QG1T, QG2T, QG3T
			Type 30 required if MOVE(3)=1.
30	1	3I5	NST, NSEP, ISEP
			Include types 31 through 34 only if NST≥ 2, omitting type 34 if NSEP=0.
31	NST/8	8F10.0	XSS(I)
32	NST/8	8F10.0	ZSS(I)
33	(NST-1)/8	8F10.0	QSV(I)
34	NSEP/8	8F10.0	WKS(I)
			The case-dependent group, record types 35 through 40 is to be included for all cases, noting the exceptions given.
35	1	10A8	TITLE
36	1	4F10.0	TEST, TRUN, TPNT, TMACH
37	1	5F10.0	AMREF, THETS, CLIFT, CDRAG, CMOM
			At this point, include a record of type 12 for each network having IST=6 and IRHSI=3.
			Include the required number of type 38 records for each network having IRHSI=2.
38	(NL-1)* (ML-1)/8	8F10.0	BCENP(I)
			Include a record type 39 for each network having NFBP> 0.
39	1	8F10.0	BCONP
			NCPRT is summation of NCPR over all networks.
40	NCPRT/8	8F10.0	BCONP(I)

Definition of Input Variables

CASID		Case identification number to be recorded on SIF file. Should have integer value for proper SIF file usage. Value of 0.0 causes no SIF file to be written.
MOVE		A 4-element integer array for program control (see Appendix A).
ISYM		Symmetry flag.
	= 0	for no symmetry.
	= 1	for symmetry about y=0 plane. Model body and sting are not reflected.
NNET		Total number of networks.
XROT, ZROT		x- and z-coordinates of center of rotation of sting support system.
NL, ML		Number of n-lines and m-lines for a network.
NLR		Receiving network number for linked output (see Appendix B).
IDEFN		Panel geometry input flag.
	= 0	for simplified orthogonal network input form.
	= 1	for input listing of panel corner point coordinates.
IST		Source distribution type.
IDT		Doublet distribution type.
IRHSI		Right hand side constant input flag.
	= 0	for $B = 0$.
	= 1	for B read from record type 13 in paneling difinition group.
	= 2	for B read from record type 38 in case-dependent data group.
	= 3	for SFM read from record type 12 in case-dependent data group.
NCPR		Number of redefined control points in network.
IBCIP		Boundary condition type at network interior control points.
IBCEP(I)		Boundary condition type at control points on network edge I.
IBCCP(I)		Boundary condition type at control points at network corner I.
ITMX		Maximum number of iterations allowed for satisfaction of exact pressure coefficient boundary conditions.
CNVU		Convergence criterion for maximum residual of nonlinear terms in u as function of C_p.
RFU		Relaxation factor for update of exact C_p boundary conditions.
FSN		Smoothing factor in direction of varying n.
FSM		Smoothing factor in direction of varying m.
NDIR, MDIR, NORM		Coordinate direction of varying n-index, varying m-index, and network normal respectively. Use 1, 2, 3 for x, y, z.
XNO		Value of NORM coordinate at network plane.
XND(I)		Array of n-line coordinates in NDIR direction (I=1 to NL).
XMD(I)		Array of m-line coordinates in MDIR direction (I=1 to ML).
PDEFP(I)		Coordinates of panel corner points in network (I=1, 2, 3 for x, y, z).
SFM(I)		Array of panel center source strength factors for all longitudinal panel rows in IST=6 network.
BCENP(I)		Array of right hand side constant B for all panel center points in network.

IPOINT		Panel index number to define panel normal recession direction of free boundary point.
IBCT		Boundary condition type.
PCONP(I)		Control point coordinates (I=1, 2, 3 for x, y, z).
SCONP(I)		Components of unit normal vector used for boundary condition type 3 (I=1, 2, 3 for x, y, z).
ICONP		Local control point index within network.
NROW		Number of straight rows of flow survey points.
IDAT		Uniformity flag for flow survey point spacing.
	$=0$	for uniform point spacing in all rows.
	>0	use 1, 2, or 3 for x, y, or z coordinate values, respectively, given in DAT.
NDAT		Number of non-uniformly spaced coordinate values given in DAT.
DAT(I)		Array of coordinate values of non-uniformly spaced points projected on the axis indicated by IDAT. Include only those points lying between the first and last points of the row.
IPCH		Coordinate system and uniformity flag for flow survey points.
	$=0$	for uniformly spaced points defined in tunnel coordinates.
	$=1$	for uniformly spaced points defined in model coordinates.
	$=2$	for non-uniform points defined in tunnel coordinates.
	$=3$	for non-uniform points defined in model coordinates.
NPROW		Number of points in a row of flow survey points. If IPCH=2 or 3, NPROW must equal NDAT+2.
X1, Y1, Z1		Coordinates of first point in a row of flow survey points.
X2, Y2, Z2		Coordinates of last point in a row of flow survey points.
NBS		Number of body stations.
NWS		Number of wing stations.
NTS		Number of tail stations.
NSEB		Number of consecutive body segments having separated flow.
ISEB		Index of initial body segment having separated flow.
XMROT, ZMROT		x- and z-coordinates of center of rotation in model coordinate system.
DTHET		Pitch angle of model coordinate system relative to sting, degrees.
ZWING, ZTAIL		z-coordinate of wing reference plane or tail reference plane respectively in model coordinate system.
XMREF, ZMREF		x- and z-coordinates of moment reference point in model coordinate system.
SREF		Model reference area.
CREF		Model reference chord.
DA2M1		Angle-of-attack change from that corresponding to first lift coefficient to that corresponding to second lift coefficient, degrees.
XBS(I)		Array of x-coordinates of body stations in order of increasing x in model coordinate system (I=1 to NBS).
ZBS(I)		Array of z-coordinates of body stations in model coordinate system (I=1 to NBS).
QBV(I)		Volume of body segment between stations I and I+1 (I=1 to NBS−1).

WKW(I)	Array of wake widths behind body segments with separated flow (I=1 to NSEB).
YWG(I)	Array of y-coordinates of wing stations in order of increasing y (I=1 to NWS).
XCW(I)	Array of x-coordinates of wing station mid-chord points in model coordinate system (I=1 to NWS).
CW(I)	Array of local wing chords (I=1 to NWS).
QS0(I), QS1(I) QS2(I), QS3(I)	Coefficients of multipole representation of wing section thickness distribution at wing station I (see Appendix C).
QG01(I), QG11(I) QG21(I), QG31(I)	Coefficients of multipole representation of wing chordwise circulation distribution at first lift coefficient at wing station I (see Appendix C).
QG02(I), QG12(I) QG22(I), QG32(I)	Coefficients of multipole representation of wing chordwise circulation distribution at second lift coefficient at wing station I (see Appendix C).
YTL(I)	Array of tail station y-coordinates in increasing order (I=1 to NTS).
XCT(I)	Array of x-coordinates of tail station mid-chord points in model coordinate system (I=1 to NTS).
CT(I)	Array of local tail chords (I=1 to NTS).
QS0T(I), QS1T(I) QS2T(I), QS3T(I)	Coefficients of multipole representation of tail section thickness distribution at tail station I (see Appendix C).
QG0T(I), QG1T(I) QG2T(I), QG3T(I)	Coefficients of multipole representation of tail chordwise circulation distribution at tail station I (see Appendix C).
NST	Number of sting stations.
NSEP	Number of consecutive sting segments having separated flow.
ISEP	Index of initial sting segment having separated flow.
XSS(I)	Array of sting station x-coordinates at THETS=0 relative to center of rotation in increasing order (I=1 to NST).
ZSS(I)	Array of sting station z-coordinates at THETS=0 relative to center of rotation (I=1 to NTS).
QSV(I)	Volume of sting segment between stations I and I+1 (I=1 to NST−1).
WKS(I)	Separated flow wake width behind sting segment between stations I+ISEP−1 and I+ISEP (I=1 to NSEP).
TITLE	80 character case identification label.
TEST, TRUN, TPNT	Heirarchic case identifiers to be passed to TAPE3.
TMACH	Tunnel Mach number passed to TAPE3.
AMREF	Reference Mach number for PANCOR solution.
THETS	Pitch angle setting of sting support system, degrees.
CLIFT	Model lift coefficient.
CDRAG	Model drag coefficient.
CMOM	Model pitching moment coefficient.
BCONP(I)	Array of right hand side constant B.

Array Size Limitations

Program dimensions limit the maximum size of certain input variable arrays and combinations thereof as follows:

Quantity	Name	Maximum
Number of networks	NNET	20
Number of panel defining points		1200
Total number of unknowns		600
Number of redefined control points		300
NL for each IST=9 network		8
NL for each IDEFN=0 network		20
ML for each IDEFN=0 network		25
Number of body stations	NBS	50
Number of wing stations	NWS	20
Number of tail stations	NTS	20
Number of sting stations	NST	70
Number of field survey points		600

In addition, the number of stored influence coefficients must not exceed 1,600,000. The actual number written to storage is given by the output variable MLWD (see fig. 3b concluded).

Program Organization and Computer Interface

Program PANCOR is written in FORTRAN 77 with minor exceptions and is suitable for automatic vectorization with the CDC FTN200 Cycle 670 compiler and the CDC VSOS Version 2.3 operating system.

The program is made up of 24 code modules linked by the calling paths shown in fig. 2. The MAIN program is a simple executive routine which calls the seven major groups of subroutines in sequence and records the CPU time utilized in each. The INPUT group of subroutines reads all input data and deals with panel and control point geometry. The SFIT group produces data relating the higher order coefficients of the singularity distribution on each panel to the singularity strengths at neighboring control points. These data are written panel by panel to a scratch file identified as TAPE1 which is accessed in the MATA, PCOUT, and FIELD subroutines. The RECESS routine performs final adjustments to the control point locations. The next group of routines generates much of the problem forcing data accumulated on the right hand side of the matrix equation including those representing the test model and support sting. In the MATA group, the aerodynamic influence coefficients for all panels and source lines are calculated, accumulated according to the higher order singularity coefficients, stored for subsequent use and assembled according to boundary condition type into the primary coefficient matrix. All of these operations are performed in a single network loop to minimize data paging into and out of core memory. The basic influence coefficient storage array has a dimension of 1,600,000 and is accessed again in subroutine PCOUT. A smoothing matrix is created if called for and is summed with the primary coefficient matrix.

The matrix equation is solved in the MATSOL group. The solution is iterated to update the exact pressure coefficient boundary conditions. The gaussian elimination subroutine used is a Langley math library routine which factors the linear coefficient matrix only for the first solution and simply performs a back substitution for subsequent iterations. The PCOUT subroutine prepares the basic solution output data at the panel network control points. The FIELD group uses the singularity strengths defined by the solution to produce a flow survey at new field points, either calculated by the program for evaluating model corrections, or arbitrarily specified by the user. This requires the calculation of new aerodynamic influence coefficients but data handling is minimized by accumulating the results directly in the output arrays.

Five files are opened by the program. TAPE1 is a binary file which, as was previously noted, is a scratch file written and read by the program. The remaining files are coded files. The input data file is identified as TAPE5, and TAPE6 is the file used to format the printed output. TAPE2 and TAPE3 are special output files used to convey solution data to plotting utilities. They are written in the format of a Transferable Output ASCII Data (TOAD) file as described in ref. 6.

Toad File Output

TAPE2 contains solution and field survey results in the TOAD file format and is intended for postprocessing by one of the graphics utility programs in the Langley Research Center system of data processing utilities. The names in the TAPE2 file LABEL record are:

CASE, NETWORK, ROW, POINT	Heirarchic data identifiers.
XLOC, YLOC, ZLOC	Point coordinates.
VXTOT, VYTOT, VZTOT	Components of total velocity.
VXINT, VYINT, VZINT	Components of interference velocity.
PCOEF	Value of pressure coefficient.
PHI	Perturbation potential.
SDX	Longitudinal integral of panel source strength.
DELM, DALPH	Interference increments in Mach number and angle of attack.
DELMN, DALPHN	Interference increments omitting sting interference.

The value in CASE starts with CASID from record 1 of the input data file and is incremented by unity for subsequent cases in a multi-case run. NETWORK values from 1 to NNET give data at panel center control points at ROW values from 1 to NL−1 and POINT values from 1 to ML−1. Generating networks in a linkage set are omitted unless IST=9. Data given for an IST=9 network are at slot control points at ROW values from 1 to NL−2 and interference velocity components are not given; instead, VXINT contains the x location of the line segment end where S is quantified and VZINT contains the line source strength normalized to an equivalent homogeneous normal velocity, $-S/2d$. Data from field survey rows are identified by a NETWORK value of NNET+1 and are given for ROW values from 1 to NROW and POINT values from 1 to NPROW. The TAPE2 output just described is the standard output included if MOVE(1) is input as 1 or more. If MOVE(1) is 0 or 1, the TAPE2 output is limited to that from the field survey rows.

TAPE3, also written in TOAD file format, contains the interference corrections at the model together with identifying and correlating data. The names given to the data are:

TEST, RUN, POINT	Case identifiers.
MACH, CL	Correlating data for plot abscissa.
DELMW, DALPW	Mach and alpha corrections at wing.
CDB, CDU	Drag coefficient corrections for buoyancy and upwash.
DCMUP	Pitching-moment coefficient correction for spanwise variation of upwash.
DCLSC, DCMSC	Lift and pitching-moment coefficient corrections for streamline curvature.
DELMT, DALPT	Mach and incidence corrections at tail.
DELMWN, DALPWN	Corrections as above but excluding sting interference.
CDBN, CDUN	
DCMUPN	
DCLSCN, DCMSCN	
DELMTN, DALPTN	

The TAPE3 file is small, containing only a single set of data values for each case in the PANCOR run. Because the TOAD file format is editable, however, the TAPE3 files from many PANCOR runs may be merged for convenience in making comparative plots. The TAPE2 file, on the other hand, contains many data records for each case. If many of these files are to be saved for future analysis, it might be desirable to convert tham to SIF files (see ref. 7) which are binary files requiring only two-thirds the storage space of the corresponding TOAD files.

Printed Output

The format of the printed output from program PANCOR is illustrated in fig. 3. The output shown resulted from the sample case described in Appendix D. Fig. 3, however, includes only enough of the output to illustrate the format and identify the terminology used in output headings. Fig. 3a shows the standard output which is printed if MOVE(1) is set to one. The additional geometry details printed if MOVE(1) is set to 2 or 4 are illustrated in fig. 3b. The more detailed solution results printed if MOVE(1) is set to 3 or 4 are illustrated in fig. 3c. The additional solution results include a listing headed "Flow at Control Points" in which the results given at points having boundary condition type 4 apply to the exterior domain. If MOVE(1) is set to zero, the printed output is reduced to that pertaining to the field surveys, headed only by the case number and title and the last line of the iteration history. If a model exists, an appropriate set of field points is generated automatically and used to calculate the data corrections written to the TAPE3 TOAD file as described in the preceding section. These corrections are printed as part of the field point output. If MOVE(1) is set to -1, the printed output consists only of the model corrections and the identifying header data.

A number of input quantities are repeated in the printed output to aid in case identification and input verification. These quantities are identified in the output by the same variable names used for the input data file and are defined in a preceding section. Additional output quantities are defined below.

Definition of Output Quantities

Standard output, MOVE(1)=1

NNE	Network index.
NDEFP	Number of defining points in network.
NDEFPL	Cumulative number of defining points in preceding networks.
NCENP	Number of panels (center points) in network.
NCENPL	Cumulative number of panels in preceding networks.
NCONP	Number of control points in network.
NCONPL	Last global control point index preceding current network.
NSSP	Number of source singularity panels in network.
NSSPL	Cumulative number of source panels in preceding networks.
NDSP	Number of doublet singularity panels in network.
NDSPL	Cumulative number of doublet panels in preceding networks.
ICONP	Global control point index.
QBS	Strength of point source in model body representation.
QBD	Strength of line doublet segment in model body representation.
QSS	Strength of point source in sting representation.
QSD	Strength of line doublet segment in sting representation.
ITER	Iteration step number.
IUMX	Control point having largest change in u in current iteration, identified by position in ordered consecutive array of all control points with type 1 boundary condition.
DUMX	u change in current iteration at IUMX point.

U1	u perturbation at upstream closure panel. For correct value, the upstream closure panel must be defined by the first type 4 record in the input data file.
STIME	Cumulative computer CPU time used for matrix equation solution.
X, Y, Z	Nominal coordinates of control point where results are given, solution domain side of panel is implied in panel center output listing, and slotted wall output listing.
VX, VY, VZ	Components of total velocity at control point.
VXINT, VYINT, VZINT	Components of interference velocity at control point.
CP	Pressure coefficient.
INTSDX	Integral of panel source strength in x direction from m=1 network line to present position.
S	In slotted wall output listing, line source strength at line source quantifying point.
PHI	Perturbation potential at X, Y, Z.
IROW	Row index identifying FIELD survey row.
POINT	Point index in FIELD survey row.
DELM	Increment in Mach number due to tunnel and sting interference.
DALPH	Increment in angle of attack (degrees) due to tunnel and sting interference.
TIME	CPU time in seconds from start of job.
DTIME	CPU time increment used in each group of subroutines.
PETIME	CPU time increment used in each group of subroutines expressed as percent of CPU time for current case.

<u>Additional geometry output, MOVE(1)=2 or 4</u>

IDEFP	Global index of defining points.
NPB	Number of panel boundaries.
X, Y, Z	Panel center coordinates. (Panel singularity fit output is in incompressible domain).
XN, YN, ZN	Components of panel unit normal vector.
AREA	Panel area, in incompressible domain.
NNN1	Number of neighboring control points used in bilinear singularity fit.
NNN2	Number of neighboring control points used in biquadratic singularity fit.
FP(X, Y, Z)	Final coordinates of control points after recessing from panel surfaces and network edges.
ISF	Singularity flag indicating source, doublet or both.
NS	Number of terms in panel source distribution equation.
ND	Number of terms in panel doublet distribution equation.
IJF	Flag indicating existence of control points exactly coplanar with any panel in network. If flag is set, a warning message is issued indicating number of control points (including those reflected by symmetry) coplanar with that panel. Warning may be ignored if all coplanar control points lie outside the panel boundaries.
NFP	Number of influenced points for influence coefficient computation.
MLWD	Cumulative number of words stored in influence coefficient storage array.
LPF	Cumulative number of large pages of virtual memory filled by influence coefficient array.

Additional solution output, MOVE(1)=3 or 4

NRM	Number of rows in matrix equation.
CENP	Global center point index.
S	Source strength at panel center.
GSX, GSY, GSZ	Components of panel source gradient.
D	Doublet strength at panel center.
GDX, GDY, GDZ	Components of panel doublet gradient.

Appendix A

The MOVE Array

MOVE is a 4-element integer array used for program control. The available options for each element are listed below.

MOVE(1)		Printed output control.
	$= -1$	Model correction output only.
	$= 0$	Field survey and model correction output only.
	$= 1$	Standard output.
	$= 2$	Additional printed geometry output.
	$= 3$	Additional printed solution output.
	$= 4$	Additional printed geometry and solution output.
MOVE(2)		Field survey control.
	$= 0$	No field computation.
	$= 1$	Read new field specifications.
	$= 2$	Use field specifications from previous case.
	$= 3$	Same as 2 (reserved for future use).
	$= 4$	Used internally to end case after divergent iteration.
	$= 5$	Used internally to end job after last case.
MOVE(3)		Model and sting control.
	$= 0$	No test model.
	$= 1$	Read new model and sting specifications.
	$= 2$	Use model and sting specifications from previous case.
MOVE(4)		Process control.
	$= 0$	Read new paneling geometry and execute complete program.
	≥ 1	Use previous case paneling geometry.
	≥ 2	Use previous case singularity fit.
	≥ 3	Use previous case aerodynamic influence coefficients.
	$= 4$	Use previous case factored matrix.

Savings in computer resources can be achieved by executing multiple cases in a single job submission with judicious use of MOVE(4). Constraints on the allowable use of MOVE(4) are given below.

MOVE(4)=0 must be used for:

a. First case in input file.

b. Any change in panel geometry or other data in input record types 3 through 15.

MOVE(4)$\leq$ 1 must be used for any case in which Mach number differs from the previous case.

MOVE(4) values of 2 and 3 were used in program development but are of little use with the program in its present form.

MOVE(4)=4 requires the least computing time and may be used for all cases not requiring MOVE(4) values of 0 or 1.

Appendix B

Network Output Linkage

The listing of solution output gives the flow characteristics on the positive normal side of the panel at the center point of each panel in each network, and optionally includes the panel singularity strengths and gradients. If the boundary condition is type 4, the aerodynamic influence coefficients describe the flow properties on the opposite side of the panel. The local doublet strength and gradients and source strength are then used to transfer the flow potential and velocity components to the positive normal side of the panel. Network output linkage provides the capability to combine the source strengths and gradients of all coplanar networks within each linked group.

The program assigns a network number NNE in sequence from one to NNET in the same order in which the networks are defined by the type 4 records in the input data file. Groundrules for the use of linkage are listed below.

1. Linkage occurs in groups with one receiver network and one or more generator networks in each group.

2. Doublet panels may exist only in the receiver network and must not exist in the generator networks.

3. The network number of each generator network in a linkage group must be higher than that of the receiver network for that group and lower than that of the receiver network for the next group. Non-linked networks may be interspersed at will.

4. Linkage is invoked by setting NLR for each generator network in one group equal to the receiver network number for the same group. NLR for each receiver or non-linked network should be set to zero.

5. All networks involved in linkage must be defined with IDEFN=0 and those in each group must have identical values of NDIR, MDIR, NORM and XNOR. (Only flat, orthogonally oriented, coplanar networks may be linked together.)

Appendix C

Model and Sting Representation

Distributed Singularity Model

The representation of the test model provided in PANCOR is evolved from that used in program LINCOR by Rizk and Smithmeyer (ref. 5) and is the same as that used in STIPPAN (ref. 2), but is extended in PANCOR to provide for matching specified values of lift, drag and pitching moment coefficients. The basic representation is described more fully in ref. 1. The model consists of three components, body, wing and tail. Each component is defined by input data given at a specified number of stations. If the number of stations given for any component is less than two, no further input data is read for that component and it makes no contribution to the model perturbation. For convenience of geometry input, separate reference coordinate systems are used for the model and for the sting. These two systems, together with the wind tunnel coordinate system share a common plane of symmetry at y=0. The center of sting rotation is the origin of the sting coordinate system and is located in the model reference system by the coordinates XMROT and ZMROT. The angle DTHET is the pitch orientation of the model reference system relative to the sting axis. The model and sting are then located in the tunnel by the sting rotation center coordinates XROT and ZROT in the tunnel coordinate system and the sting pitch angle THETS.

The Model Body. The body representation makes use of inclined slender body principles in which a point source represents a change in cross section area scaled by cosine of angle of attack, and a line doublet segment represents the local cross section area scaled by sine of angle of attack. The present program applies this concept segment by segment to accommodate an irregular body camber shape. The body axis is located in the y=0 plane. Body input data should describe the full body rather than a half body because body influence computations are independent of the input value of ISYM. The input quantities NBS, XBS, and ZBS give the number and coordinates of stations along the body axis and the volume of each segment between stations is input into QBV. A separated wake is presumed to trail from the blunt base of the last body segment. The wake displacement is the cross section area of the last segment scaled by cosine of the segment angle of attack. This wake may be eliminated by appending a dummy segment having zero volume to the end of the body. Integration of the body with a sting is discussed in the subsequent section describing the sting representation.

Capability is provided to represent additional wake blockage due to flow separation from inclined body segments. NSEB is the number of consecutive body segments generating a wake, ISEB is the segment number of the first segment in the separated flow series and the wake width behind each separated flow segment is read into WKW. The equivalent wake cross section area behind each segment is the wake width WKW multiplied by the projected length of the body segment axis on the tunnel z-axis.

The Model Wing. The wing lies in the z=ZWING plane in the model coordinate system and is described by input data at the number of wing stations specified by NWS. The YWS array gives the y-coordinate of each station. If the symmetry option is selected (ISYM=1) the stations given should apply to the half wing on one side of the y=0 plane. The far field perturbations due to wing thickness and lift are approximated by representing the chordwise distributions of thickness and lift at each wing station by the first four members of a multipole singularity series located at the half-chord point of the wing station. The x-locations of the half-chord points are read into the XCW array.

The multipole coefficients required to complete the wing input data at each wing station may be evaluated as follows. Let $X_1 = x - \mathrm{XCW}$, let the thickness distribution $t(x)$ and the lift distribution $\gamma(x)$ be defined from the section leading edge $X_1 = -c/2$ to the trailing edge $X_1 = c/2$. Further, express the thickness gradient as $\sigma = \partial t/\partial x$. Then the thickness multipole coefficients are given by

$$\mathrm{QS0} = \int_{-c/2}^{c/2} \sigma dX_1 = t_{TE}$$

$$\text{QS1} = \int_{-c/2}^{c/2} \sigma X_1 dX_1 = t_{TE}\left(\frac{c}{2}\right) - \int_{-c/2}^{c/2} t dX_1$$

$$\text{QS2} = \int_{-c/2}^{c/2} \sigma X_1^2 dX_1 = t_{TE}\left(\frac{c}{2}\right)^2 - \int_{-c/2}^{c/2} t X_1 dX_1$$

$$\text{QS3} = \int_{-c/2}^{c/2} \sigma X_1^3 dX_1 = t_{TE}\left(\frac{c}{2}\right)^3 - \int_{-c/2}^{c/2} t X_1^2 dX_1$$

Note that the integrals of the form $\int tX_1^n dX_1$ are the thickness coefficients of the series used by Rizk and Smithmeyer (ref. 5) which is applicable only for zero trailing-edge thickness. The present series can be evaluated from an "equivalent inviscid" thickness distribution in which t_{TE} represents the wake displacement thickness giving rise to wake blockage.

The lift multipole coefficients at each wing station for a particular wing lift coefficient are given by

$$\text{QG0} = \int_{-c/2}^{c/2} \gamma dX_1$$

$$\text{QG1} = \int_{-c/2}^{c/2} \gamma X_1 dX_1$$

$$\text{QG2} = \int_{-c/2}^{c/2} \gamma X_1^2 dX_1$$

$$\text{QG3} = \int_{-c/2}^{c/2} \gamma X_1^3 dX_1$$

which are identical to those used in ref. 5. The vorticity in the above integrals is the lifting vorticity component at a particular wing lift coefficient normalized by the reference velocity.

The Model Tail. The tail input quantities are evaluated in a manner completely analogous to that described above for the wing. Note, however, that the vorticity scaling is arbitrary for the tail because of the pitching moment matching procedure discussed below.

Aerodynamic Coefficient Matching. The PANCOR program is able to make scaling and other adjustments to the test model data entered in record types 19 through 29 to be appropriate for the values of CLIFT, CDRAG and CMOM entered in record type 37. For matching lift coefficient, two sets of the wing lift multipole coefficients, corresponding to two different wing lift coefficients are entered in record type 27. The program evaluates the product $C_L \cdot \text{SREF}$ for each set as two times the trapezoid rule integration over the full wing span of QG01 or QG02. A set of QGx appropriate for the input value of CLIFT is then calculated by linear interpolation (or extrapolation). The tail lift is accounted for in this process.

The pitching moment match accounts for contributions of the wing, tail, and the line doublet segments used in the body representation. If a tail is not present, the input value of CMOM is matched by adding a constant to all values of QG1, thereby shifting the wing lift effects upstream or downstream as required. If a tail is present, the tail effectiveness is evaluated by appropriate integrations of QG0T and QG1T across the tail span and then all of the QGxT are scaled as required to achieve a match. If CMOM is input as 99, all QGxT are scaled to zero and no adjustmant to the wing QG1 is made.

A fairly crude approximation is used in matching the input value of CDRAG. It is assumed that the drag of the model representation is equivalent to complete loss of momentum in a wake having a cross section area equal to the net source strength of the model representation normalized by reference velocity. This simple approximation is believed to be acceptable for use in the PANCOR program because with measured pressures used as wall boundary conditions, a change in net model source strength causes a compensating change in wall flux with only minor effects on the assessed tunnel interference. The model net source strength is evaluated from the wing and tail trailing edge thicknesses and the point sources used in the body representation. After accounting for induced drag, any required adjustment is accomplished by a change in wing trailing edge thickness which is distributed across the span in proportion to the values of QS1.

Sting Representation

The input data form for the sting is analogous to that described for the model body in this Appendix. The sting station coordinates XSS and ZSS are expressed in the sting coordinate system having its origin at the sting center of rotation and oriented at a pitch angle THETS relative to the tunnel coordinate system.

The sting is represented as a segmented inclined slender body by use of point sources and line doublets as described for the model body. In the case of the sting, however, the first point source, which would represent the growth in cross section area from zero to that of the first sting segment, is omitted. With this arrangement, a sting which continues the body lines behind the blunt base of a model body may be described with the first sting station located at the last body station. The combined representation is then equivalent to a sting fully replacing the wake behind the blunt body. If the sting is immersed in the wake behind a larger diameter model body base, the first sting station should be located farther downstream where the sting can be expected to start influencing the flow outside of the body wake. If the nose of the sting is exposed to the unshielded tunnel flow, the sting should be described with a dummy zero-volume segment placed ahead of the actual sting nose.

It should be noted that the location of the model-sting interface is significant in that the interference perturbation at any point is calculated as the perturbation summed over all singularities except those included in the model representation.

Appendix D

Sample Case

The following data file is set up to perform an interference assessment of a Mach number 0.7 test point in the National Transonic Facility (NTF) at NASA Langley Research Center. The test section is about 8.2 feet square with solid side walls and six slots each in the top and bottom walls extending from tunnel station 0.5 to station 25.0. Pressure coefficients obtained from longitudinal rows of orifices halfway between slots on the top and bottom walls and a single pressure at station 23.125 on the side wall center line are used in the assessment problem. The test model is a generic subsonic transport model referred to as Pathfinder I. The volume of a vertical tail is accounted for by adjustments to the values of QS0T and QS1T at the horizontal tail center line.

Fourteen panel networks are used to simulate the tunnel. Networks 1 and 14 provide the upstream and downstream closures respectively. Networks 2 and 9 are the doublet networks for the slotted top and bottom walls, networks 3 and 10 model the discrete wall slots, networks 4 and 11 are the IST=6 networks used to model the reentry flap region and wall step, and networks 5 and 12 are specified source strength networks used to represent wall divergence. Network 6 is the doublet network for the tunnel side wall and networks 7 and 8 are IST=2 prescribed source networks to represent the effective sidewall shape. The relatively sharp sidewall bend at the diffuser entrance is simulated by network 8 while network 7 provides an opportunity to represent boundary layer growth in the test section. The two phenomena are represented in separate networks to avoid unwanted upstream propagation of source gradients from the sharp bend into the test section. Network 13 approximates the sting support sector as a wedge-nosed plate.

Sample Case Input Data File

The record type number is shown in brackets in the left hand column to assist the user and is not a part of the input data file.

```
[1]   1.
[2]     1   1   1   0
[3]      1   14 13.000    0.
[4]     2   2   0   0   1   0   0   0   4
 |      5  25   0   0   0   3   0   0   4   4  12   4   4   4   4   4   4
 |      5  15   2   0   9   0   0  39   1
 |      4   5   2   0   6   0   3   0   6
 |      2   3   2   0   1   0   2   0   0
 |      6  25   0   0   0   3   0   0   4   4   4   4   4   4   4   4   4
 |      2   7   6   0   2   0   1   0   0
 |      2   6   6   0   2   0   1   0   0
 |      5  25   0   0   0   3   0   0   4   4   4   4  12   4   4   4   4
 |      5  15   9   0   9   0   0  39   1
 |      4   5   9   0   6   0   3   0   6
 |      2   3   9   0   1   0   2   0   0
 |      2   2   0   0   1   0   1   0   0
 v      2   2   0   0  -1   1   0   0   4
[5]          100      1.E-10 1.
[6]  0.        0.        0.        0.        0.        0.        0.        0.
 "   0.        0.        0.        0.        0.
```

```
 [7]  0.        0.        0.        0.        0.        0.        0.        0.
  "   0.        0.        0.        0.        0.
 [8]     3    2     1 -10.
 [9]  -4.101042 4.101042
[10]  4.101042  0.
 [8]     2    1     3 -4.101042
 [9]  4.101042  3.417505  2.050521  .683507   0.
[10]  -10.      -2.       .5        2.0       3.6       5.4       7.2       9.
      10.6      12.       13.       14.       15.       16.4      18.2      20.
      21.25     22.5      23.75     25.       25.64     26.28     26.92     27.56
      30.
 [8]     2    1     3 -4.101042
 [9]  4.101042  3.417505  2.050521  .683507   0.
[10]  .5        2.0       3.6       5.4       7.2       9.        10.6      12.
  "   13.       14.       15.       16.4      18.2      20.       25.
 [8]     2    1     3 -4.101042
 [9]  4.101042  2.597326  1.230313  0.
[10]  20.       21.25     22.5      23.75     25.
 [8]     2    1     3 -4.101042
 [9]  4.101042  0.
[10]  .5        25.       30.
 [8]     3    1     2 4.101042
 [9]  4.101042  2.460625  .820208   -.820208  -2.460625 -4.101042
[10]  -10.      -2.       .5        2.0       3.6       5.4       7.2       9.
      10.6      12.       13.       14.       15.       16.4      18.2      20.
      21.25     22.5      23.75     25.       25.64     26.28     26.92     27.56
      30.
 [8]     3    1     2 4.101042
 [9]  4.101042  -4.101042
[10]  .5        3.6       7.2       10.6      13.       15.       30.
 [8]     3    1     2 4.101042
 [9]  4.101042  -4.101042
[10]  25.000    25.640    26.280    26.920    27.560    30.000
 [8]     2    1     3 4.101042
 [9]  0.        .683507   2.050521  3.417505  4.101042
[10]  -10.      -2.       .5        2.0       3.6       5.4       7.2       9.
      10.6      12.       13.       14.       15.       16.4      18.2      20.
      21.25     22.5      23.75     25.       25.64     26.28     26.92     27.56
      30.
 [8]     2    1     3 4.101042
 [9]  0.        .683507   2.050521  3.417505  4.101042
[10]  .5        2.0       3.6       5.4       7.2       9.        10.6      12.
  "   13.       14.       15.       16.4      18.2      20.       25.
 [8]     2    1     3 4.101042
 [9]  0.        1.230313  2.597326  4.101042
[10]  20.       21.25     22.5      23.75     25.
 [8]     2    1     3 4.101042
 [9]  0.        4.101042
[10]  .5        25.       30.
 [8]     3    1     2 0.
 [9]  4.101042  -4.101042
[10]  26.486    29.642
 [8]     3    2     1 30.
 [9]  4.101042  -4.101042
[10]  4.101042  0.
```

[13]	0.	0.	0.	0.	0.	0.	
	-.0214	-.0691	-.0987	-.0862	-.0564		
	.07276						
[14]	238	1 23.125	4.101042	0.	1.	0.	0.
[15]	1	1 2.8	2.734	-4.101042			
	2	1 4.5	2.734	-4.101042			
	3	1 6.3	2.734	-4.101042			
	4	1 8.1	2.734	-4.101042			
	5	1 9.8	2.734	-4.101042			
	6	1 11.3	2.734	-4.101042			
	7	1 12.5	2.734	-4.101042			
	8	1 13.5	2.734	-4.101042			
	9	1 14.5	2.734	-4.101042			
	10	1 15.7	2.734	-4.101042			
	11	1 17.3	2.734	-4.101042			
	12	1 19.1	2.734	-4.101042			
	13	1 20.625	2.734	-4.101042			
	14	1 2.8	1.367	-4.101042			
	15	1 4.5	1.367	-4.101042			
	16	1 6.3	1.367	-4.101042			
	17	1 8.1	1.367	-4.101042			
	18	1 9.8	1.367	-4.101042			
	19	1 11.3	1.367	-4.101042			
	20	1 12.5	1.367	-4.101042			
	21	1 13.5	1.367	-4.101042			
	22	1 14.5	1.367	-4.101042			
	23	1 15.7	1.367	-4.101042			
	24	1 17.3	1.367	-4.101042			
	25	1 19.1	1.367	-4.101042			
	26	1 20.625	1.367	-4.101042			
	27	1 2.8	0.	-4.101042			
	28	1 4.5	0.	-4.101042			
	29	1 6.3	0.	-4.101042			
	30	1 8.1	0.	-4.101042			
	31	1 9.8	0.	-4.101042			
	32	1 11.3	0.	-4.101042			
	33	1 12.5	0.	-4.101042			
	34	1 13.5	0.	-4.101042			
	35	1 14.5	0.	-4.101042			
	36	1 15.7	0.	-4.101042			
	37	1 17.3	0.	-4.101042			
	38	1 19.1	0.	-4.101042			
	39	1 20.625	0.	-4.101042			
	1	1 2.8	0.	4.101042			
	2	1 4.5	0.	4.101042			
	3	1 6.3	0.	4.101042			
	4	1 8.1	0.	4.101042			
	5	1 9.8	0.	4.101042			
	6	1 11.3	0.	4.101042			
	7	1 12.5	0.	4.101042			
	8	1 13.5	0.	4.101042			
	9	1 14.5	0.	4.101042			
	10	1 15.7	0.	4.101042			
	11	1 17.3	0.	4.101042			
	12	1 19.1	0.	4.101042			
	13	1 20.625	0.	4.101042			
	14	1 2.8	1.367	4.101042			

[15]	15	1 4.5	1.367	4.101042				
	16	1 6.3	1.367	4.101042				
	17	1 8.1	1.367	4.101042				
	18	1 9.8	1.367	4.101042				
	19	1 11.3	1.367	4.101042				
	20	1 12.5	1.367	4.101042				
	21	1 13.5	1.367	4.101042				
	22	1 14.5	1.367	4.101042				
	23	1 15.7	1.367	4.101042				
	24	1 17.3	1.367	4.101042				
	25	1 19.1	1.367	4.101042				
	26	1 20.625	1.367	4.101042				
	27	1 2.8	2.734	4.101042				
	28	1 4.5	2.734	4.101042				
	29	1 6.3	2.734	4.101042				
	30	1 8.1	2.734	4.101042				
	31	1 9.8	2.734	4.101042				
	32	1 11.3	2.734	4.101042				
	33	1 12.5	2.734	4.101042				
	34	1 13.5	2.734	4.101042				
	35	1 14.5	2.734	4.101042				
	36	1 15.7	2.734	4.101042				
	37	1 17.3	2.734	4.101042				
	38	1 19.1	2.734	4.101042				
	39	1 20.625	2.734	4.101042				
[16]	10	0 0						
[18]	0	55 -.05	4.101	0.	26.95	4.101	0.	
	0	55 0.	2.0505	0.	27.	2.0505	0.	
	1	11 .4531	0.	-.1771	1.76555	2.5	.0408	
	1	11 2.3065	0.	0.	2.922	1.	.1763	
	1	23 -2.17	0.	-.1771	3.33	0.	-.1771	
	1	23 -2.17	.5	-.1335	3.33	.5	-.1335	
	1	23 -2.17	1.	-.0899	3.33	1.	-.0899	
	1	23 -2.17	1.5	-.0463	3.33	1.5	-.0463	
	1	23 -2.17	2.	-.0027	3.33	2.	-.0027	
	1	23 -2.17	2.5	.0408	3.33	2.5	.0408	
[19]	22	9 5	0 0					
[20]	.8301	0.	0.	-.1	.05			
[21]	.8432	0.	1.988	.4783	4.244			
[22]	-1.4633	-1.200	-.9000	-.6000	-.3000	0.	.1817	.2292
	.2767	.3242	.4287	.5427	.67577	.7897	.9037	1.0177
	1.1317	1.4	1.75	2.1	2.4	2.7033		
[23]	0.	0.	0.	0.	0.	0.	-.0111	-.01694
	-.01973	-.02194	-.02412	-.02504	-.02444	-.02194	-.01797	-.01512
	-.01487	0.	0.	0.	0.	0.		
[24]	.01194	.03954	.05298	.05412	.05412	.03258	.00899	.00920
	.00932	.02072	.02277	.02660	.02262	.02228	.02188	.02170
	.04863	.06039	.05401	.03914	.03135			
[26]	0.	.6567	.95	0.	0.	0.	0.	
	.24	.6567	.95	0.	0.	0.	0.	
	.24	.6567	.95	.005947	-.08107	-.06197	-.04642	
	.533	.7717	.7332	.00387	-.0427	-.0252	-.0144	
	.8267	.8871	.5158	.00355	-.02167	-.00940	-.00396	
	1.203	1.08335	.4463	.00293	-.0144	-.00530	-.00184	
	1.5792	1.27955	.3768	.002326	-.01007	-.00311	-.00094	
	1.9125	1.4563	.3153	.001784	-.00692	-.00180	-.00045	
	2.2117	1.6142	.26	.001318	-.00470	-.00102	-.00022	

[27]	.108	.00293	.0143	.00030	.320	-.0448	.0369	-.00727
	.105	.00556	.0115	.00051	.300	-.0308	.0277	-.00466
	.105	.00556	.0115	.00051	.300	-.0308	.0277	-.00466
	.097	.00806	.0067	.00052	.272	-.0185	.0165	-.00183
	.085	.00658	.00258	.00022	.241	-.0120	.0074	-.00070
	.070	.00572	.00134	.00014	.211	-.0086	.0044	-.00035
	.055	.00500	.00073	.00009	.177	-.0060	.0027	-.00018
	.040	.00420	.00035	.00006	.140	-.0038	.0016	-.00009
	.027	.00320	.00015	.00003	.102	-.0017	.0006	-.00002
[28]	0.	2.412	.5371	.01981	-.14461	-.00857	-.00376	
	.2068	2.412	.5371	.002632	-.01896	-.00857	-.00376	
	.4101	2.516	.4261	.002088	-.01193	-.00428	-.00149	
	.6133	2.620	.3152	.001544	-.00653	-.00173	-.00045	
	.8166	2.723	.2042	.001001	-.00274	-.00047	-.00008	
[29]	.250	-.075	.0064	-.0034				
	.149	-.025	.0041	-.00085				
	.077	-.0045	.0013	-.00012				
	.049	-.0072	.00045	-.00010				
	.029	-.0040	.00020	0.				
[30]	34	0	0					
[31]	2.6162	2.7670	2.9266	3.0953	3.2737	3.4625	3.6621	3.8733
	4.0966	4.3327	4.5825	4.8468	5.1262	5.4217	5.7343	6.0649
	6.4146.	6.7844	7.1756	7.4272	7.6967	7.9855	8.2948	8.7762
	9.3504	10.5	11.237	11.975	12.749	13.488	14.539	15.592
	16.644	19.810						
[32]	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.						
[33]	.00980	.01069	.01165	.01272	.01392	.01524	.01672	.01938
	.02440	.03141	.04014	.05090	.06419	.08054	.10055	.11554
	.12271	.13034	.09132	.11229	.13809	.16974	.31293	.45895
	1.23863	.9946	1.1134	1.2985	1.3084	1.7969	1.6768	1.5526
	4.4998							
[35]	PATHFINDER I IN NTF - SAMPLE CASE							
[36]	21.	18.	399.	.79885				
[37]	.79947	2.58044	.55950	.03840	-.07500			
[12]	.05668	.22867	.47877	.80678				
"	.05668	.22867	.47877	.80678				
[38]	.00186	-.03484						
"	.00195	-.03487						
[39]	.02742							
[40]	.01448	.01705	.02099	.01892	.01554	.01513	.01179	.01424
	.02047	.02002	.01145	.00020	-.00446	.01616	.01767	.01724
	.01930	.01646	.01350	.01437	.01567	.01575	.01606	.01096
	-.00295	-.01267	.01819	.01940	.02034	.02034	.01969	.01916
	.01919	.01939	.01923	.01773	.01200	-.00019	-.01397	.01938
	.01962	.02062	.01966	.01495	.00730	.00103	-.00130	-.00047
	.00227	.00308	-.00312	-.01235	.01198	.01847	.02238	.02406
	.01825	.00486	.00127	-.00381	-.00227	.00818	.00154	-.01177
	-.02015	.01887	.01849	.01968	.02150	.01646	.00253	-.00067
	-.00012	.00214	.00427	.00168	-.01100	-.02303		

References

1. Kemp, William B., Jr.: *Computer Simulation of a Wind tunnel Test Section With Discrete Finite-Length Wall Slots.* NASA CR-3948, 1986.
2. Kemp, William B., Jr.: *User's Guide to STIPPAN: A Panel Method Program for Slotted Tunnel Interference Prediction.* NASA CR-178003, 1986.
3. Thomas, J. L., Luckring, J. M., and Sellers, W. L., III: *Evaluation of Factors Determining the Accuracy of Linearized Subsonic Panel Methods.* AIAA Paper No. 83-1826, July 1983.
4. Kemp, William B., Jr.: *A Panel Method Procedure for Interference Assessment in Slotted-Wall Wind Tunnels.* AIAA Paper No. 88-2537, June 1988.
5. Rizk, M. H., and Smithmeyer, M. F.: *Wind Tunnel Wall Interference Corrections for Three-Dimensional Flows.* J. Airc., vol. 19, June 1982.
6. Bingel, Bradford, and Hammond, Dana: *Transferable Output ASCII Data (TOAD) File Format Description.* Computer Sciences Corp. informal report, Dec. 1985.
7. Howell, R. K., Guillebeau, E. M., and Long, R. L.: *Interface File Tape Concept.* NASA CR-159284, 1980.

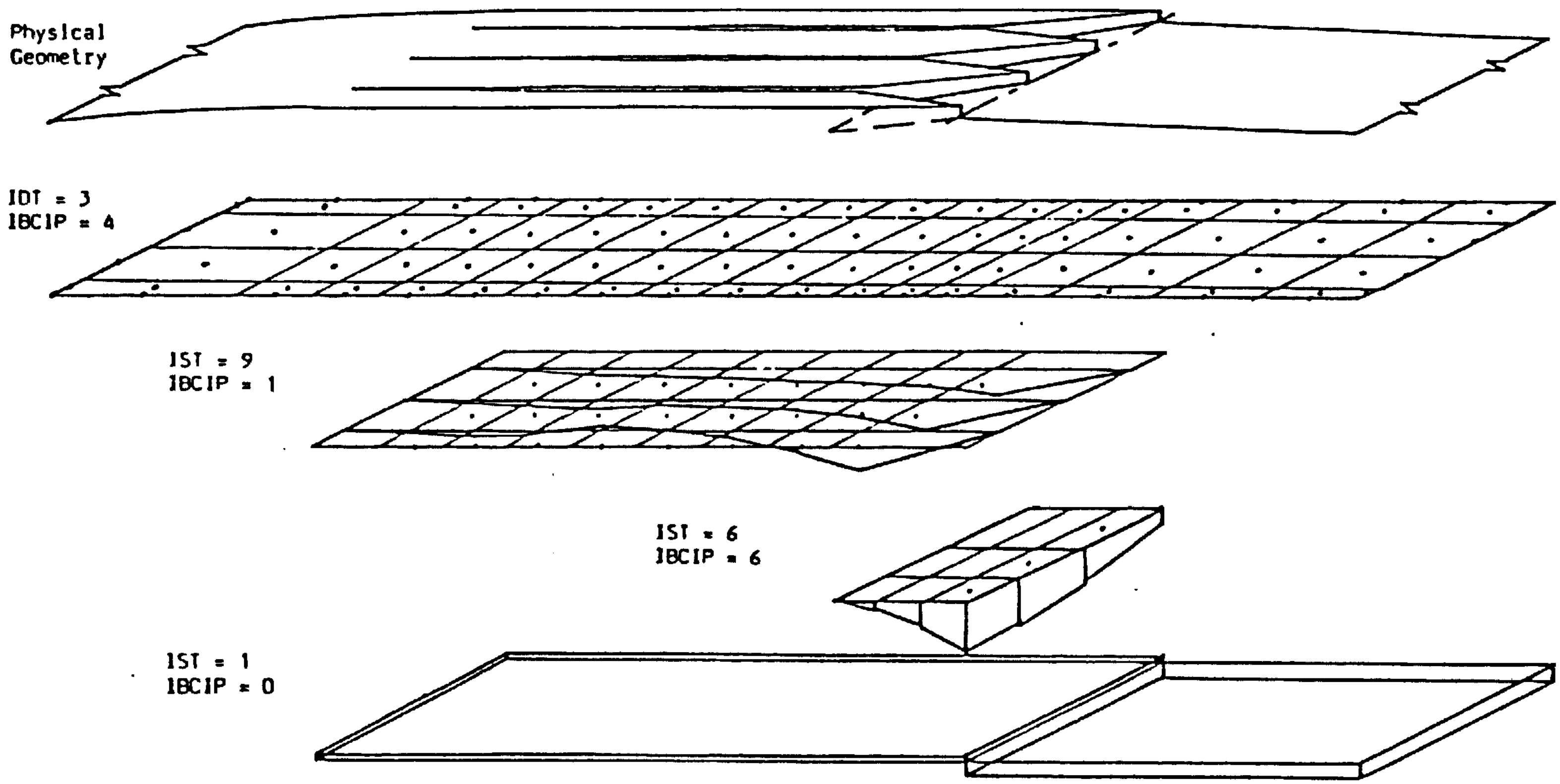
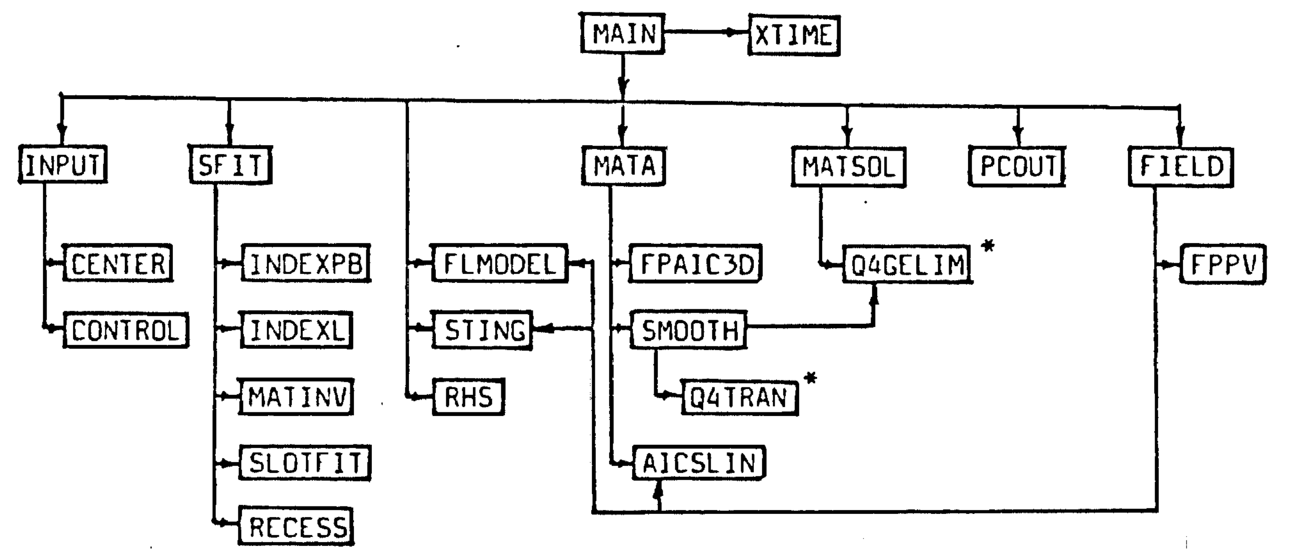


Figure 1. Network superposition and boundary conditions to represent a slotted tunnel wall.



*Q4GELIM and Q4TRAN are library subroutines

Figure 2. PANCOR program routines and calling paths.

THIS OUTPUT IS PRODUCED BY PROGRAM:

PANCOR

VERSION 2.7

A PANEL METHOD PROGRAM FOR INTERFERENCE ASSESSMENT
IN SLOTTED-WALL WIND TUNNELS.

CASE NO. 1.

PATHFINDER I IN NTF - SAMPLE CASE

AMREF= 0.79947

ISYM= 1 NNET=14

MOVE ARRAY 4 1 1 0

XROT= 13.00000, ZROT= 0.00000, THETS= 2.58044

CL = 0.55950, CD = 0.03840, CM = -0.07500

CP RELAXATION DATA
ITMX= 100, CNVU= 0.100E-09, RFU= 1.000

NETWORK INPUT DATA BELOW

NNE	NL	ML	NLR	IDEFN	IST	IDT	IRHSI	NCPR	IBCIP	IBCEP(1-4)				IBCCP(1-4)			
1	2	2	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0
2	5	25	0	0	0	3	0	0	4	4	12	4	4	4	4	4	4
3	5	15	2	0	9	0	0	39	1	0	0	0	0	0	0	0	0
4	4	5	2	0	6	0	3	0	6	0	0	0	0	0	0	0	0
5	2	3	2	0	1	0	2	0	0	0	0	0	0	0	0	0	0
6	6	25	0	0	0	3	0	0	4	4	4	4	4	4	4	4	4
7	2	7	6	0	2	0	1	0	0	0	0	0	0	0	0	0	0
8	2	6	6	0	2	0	1	0	0	0	0	0	0	0	0	0	0
9	5	25	0	0	0	3	0	0	4	4	4	4	12	4	4	4	4
10	5	15	9	0	9	0	0	39	1	0	0	0	0	0	0	0	0
11	4	5	9	0	6	0	3	0	6	0	0	0	0	0	0	0	0
12	2	3	9	0	1	0	2	0	0	0	0	0	0	0	0	0	0
13	2	2	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
14	2	2	0	0	-1	1	0	0	4	0	0	0	0	0	0	0	0

a. Standard output, MOVE(1)=1.

Figure 3. Output printed by PANCOR program.

NETWORK PANEL DATA BELOW

NNE	NL	ML	NDEFPL	NDEFP	NCENPL	NCENP	FSN	FSM
1	2	2	0	4	0	1	0.0000	0.0000
2	5	25	4	125	1	96	0.0000	0.0000
3	5	15	129	75	97	56	0.0000	0.0000
4	4	5	204	20	153	12	0.0000	0.0000
5	2	3	224	6	165	2	0.0000	0.0000
6	6	25	230	150	167	120	0.0000	0.0000
7	2	7	380	14	287	6	0.0000	0.0000
8	2	6	394	12	293	5	0.0000	0.0000
9	5	25	406	125	298	96	0.0000	0.0000
10	5	15	531	75	394	56	0.0000	0.0000
11	4	5	606	20	450	12	0.0000	0.0000
12	2	3	626	6	462	2	0.0000	0.0000
13	2	2	632	4	464	1	0.0000	0.0000
14	2	2	636	4	465	1	0.0000	0.0000
TOTAL			640		466			

NETWORK SINGULARITY / BC SPECIFICATION BELOW

NNE	IST	IDT	IBCIP	NCPR	IRHSI	NCONPL	NCONP	NSSPL	NSSP	NDSPL	NDSP	NFBP
1	1	0	4	0	0	6	1	0	1	0	0	0
2	0	3	4	0	0	7	156	1	0	0	156	0
3	9	0	1	39	0	163	39	1	39	156	0	0
4	6	0	6	0	3	0	3	40	3	156	0	0
5	1	0	0	0	2	202	0	43	2	156	0	0
6	0	3	4	0	0	202	182	45	0	156	182	0
7	2	0	0	0	1	384	0	45	6	338	0	0
8	2	0	0	0	1	384	0	51	5	338	0	0
9	0	3	4	0	0	384	156	56	0	338	156	0
10	9	0	1	39	0	540	39	56	39	494	0	0
11	6	0	6	0	3	3	3	95	3	494	0	0
12	1	0	0	0	2	579	0	98	2	494	0	0
13	1	0	0	0	1	579	0	100	1	494	0	0
14	-1	1	4	0	0	579	2	101	1	494	1	1
TOTAL						581		102		495		

a. Continued.

Figure 3. Continued.

```
NON-ZERO RHS FOR NETWORK NO.  5 BELOW

   0.00186  -0.03484

NON-ZERO RHS FOR NETWORK NO.  7 BELOW

   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000

NON-ZERO RHS FOR NETWORK NO.  8 BELOW

  -0.02140  -0.06910  -0.09870  -0.08620  -0.05640

NON-ZERO RHS FOR NETWORK NO. 12 BELOW

   0.00195  -0.03487

NON-ZERO RHS FOR NETWORK NO. 13 BELOW

   0.07276

 INPUT FREE CONTROL POINT DATA BELOW

ICONP  IPNT  IBCT     PCONP(X)     PCONP(Y)     PCONP(Z)     SCONP(X)     SCONP(Y)     SCONP(Z)       BCONP
  581   238     1    23.125000     4.101042     0.000000     1.000000     0.000000     0.000000    0.027420
```

a. Continued.

Figure 3. Continued.

MODEL DESCRIPTION

NBS= 22 NWS= 9 NTS= 5
XMROT= 0.83010, ZMROT= 0.00000, THETA= 2.58044

XBS	10.70893	10.97196	11.27165	11.57135	11.87105	12.17074	12.35176	12.39895	12.44627	12.49363
	12.59792	12.71176	12.84473	12.95865	13.07272	13.18673	13.30062	13.56932	13.91897	14.26861
	14.56831	14.87130								
ZBS	0.10325	0.09140	0.07789	0.06439	0.05088	0.03737	0.01810	0.01013	0.00521	0.00086
	-0.00602	-0.01208	-0.01747	-0.02010	-0.02127	-0.02355	-0.02843	-0.02566	-0.04142	-0.05717
	-0.07068	-0.08434								
QBS	0.01637	0.03120	0.01617	0.00137	0.00000	-0.00043	0.00336	0.00183	0.00093	0.00077
	0.00052	0.00005	-0.00052	-0.00115	-0.00124	-0.00053	-0.00340	-0.00303	-0.00658	-0.00861
	-0.00978	0.00000								
QBD		0.00089	0.00258	0.00345	0.00353	0.00353	0.00827	0.01381	0.00874	0.00781
	0.00567	0.00460	0.00351	0.00199	0.00087	0.00167	0.00354	-0.00081	0.00337	0.00302
	0.00255	0.00202								

THE QG01 CORRESPOND TO WING CL = 0.32276 AND THE QG02 TO CL = 0.96698
VALUES BELOW CORRESPOND TO WING CL = 0.55394

YWG	XCW	ZCW	QS0	QS1	QS2	QS3	QG0	QG1	QG2	QG3
0.000000	12.822274	-0.092092	0.000000	0.000000	0.000000	0.000000	0.184077	-0.014198	0.022410	-0.002417
0.240000	12.822274	-0.092092	0.000000	0.000000	0.000000	0.000000	0.174976	-0.007488	0.017313	-0.001345
0.240000	12.822274	-0.092092	0.005947	-0.081070	-0.061970	-0.046420	0.174976	-0.007488	0.017313	-0.001345
0.533000	12.937157	-0.097269	0.003870	-0.042700	-0.025200	-0.014400	0.159799	-0.001471	0.010217	-0.000323
0.826700	13.052440	-0.102465	0.003550	-0.021670	-0.009400	-0.003960	0.140981	-0.000087	0.004310	-0.000110
1.203000	13.248491	-0.111300	0.002930	-0.014400	-0.005300	-0.001840	0.120598	0.000581	0.002438	-0.000036
1.579200	13.444492	-0.120134	0.002326	-0.010070	-0.003110	-0.000940	0.098780	0.001053	0.001437	-0.000007
1.912500	13.621063	-0.128091	0.001784	-0.006920	-0.001800	-0.000450	0.075885	0.001329	0.000799	0.000006
2.211700	13.778803	-0.135200	0.001318	-0.004700	-0.001020	-0.000220	0.053914	0.001442	0.000311	0.000012

THE QGOT AS INPUT CORRESPOND TO CL = 0.17095 BASED ON SREF
VALUES BELOW CONTRIBUTE CL = 0.00556

YTL	XCT	ZCT	QS0T	QS1T	QS2T	QS3T	QG0T	QG1T	QG2T	QG3T
0.000000	14.582547	-0.021271	0.019810	-0.144610	-0.008570	-0.003760	0.008132	-0.002440	0.000208	-0.000111
0.206800	14.582547	-0.021271	0.002632	-0.018960	-0.008570	-0.003760	0.004847	-0.000813	0.000133	-0.000028
0.410100	14.686442	-0.025953	0.002088	-0.011930	-0.004280	-0.001490	0.002505	-0.000146	0.000042	-0.000004
0.613300	14.790336	-0.030635	0.001544	-0.006530	-0.001730	-0.000450	0.001594	-0.000234	0.000015	-0.000003
0.816600	14.893232	-0.035273	0.001001	-0.002740	-0.000470	-0.000080	0.000943	-0.000130	0.000007	0.000000

a. Continued.

Figure 3. Continued.

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STING DESCRIPTION
   NST= 34,  NSEP=  0,  ISEP=  0

XSS    15.61355   15.76419   15.92363   16.09216   16.27038   16.45899   16.65839   16.86937   17.09245   17.32831
       17.57785   17.84189   18.12100   18.41620   18.72849   19.05875   19.40810   19.77752   20.16832   20.41967
       20.68890   20.97740   21.28639   21.76730   22.34092   23.48935   24.22561   24.96286   25.73607   26.47432
       27.52426   28.57619   29.62712   32.78991

ZSS    -0.11779   -0.12458   -0.13176   -0.13936   -0.14739   -0.15589   -0.16487   -0.17438   -0.18444   -0.19507
       -0.20631   -0.21821   -0.23079   -0.24410   -0.25817   -0.27305   -0.28880   -0.30545   -0.32306   -0.33439
       -0.34652   -0.35952   -0.37345   -0.39512   -0.42097   -0.47273   -0.50591   -0.53914   -0.57398   -0.60726
       -0.65457   -0.70198   -0.74935   -0.89188

QSS     0.00000    0.00072    0.00075    0.00081    0.00088    0.00095    0.00102    0.00275    0.00598    0.00808
        0.00943    0.01094    0.01265    0.01459    0.01678    0.00948    0.00052    0.00049    0.01075    0.01938
        0.02219    0.02550    0.03655    0.05387    0.10040    0.09821    0.05744    0.06099    0.03351   -0.02194
       -0.04234   -0.04207   -0.01970    0.00000

QSD              0.00127    0.00131    0.00135    0.00139    0.00144    0.00149    0.00155    0.00170    0.00202
     0.00246     0.00297    0.00356    0.00425    0.00504    0.00594    0.00646    0.00649    0.00651    0.00709
     0.00814     0.00934    0.01073    0.01270    0.01562    0.02106    0.02637    0.02948    0.03279    0.03460
     0.03341     0.03112    0.02884    0.02778

  ITERATION HISTORY
 ITER  IUMX        DUMX          U1       STIME

    1    13   0.1906E-01 -0.1119E-01     1.880
    2    78   0.5603E-02 -0.1132E-01     1.896
    3    78   0.4401E-02 -0.1133E-01     1.911
    4    78   0.2425E-02 -0.1133E-01     1.927
    5    78   0.9755E-03 -0.1133E-01     1.943
    6    78   0.3005E-03 -0.1133E-01     1.958
    7    78   0.7423E-04 -0.1133E-01     1.974
    8    78   0.1526E-04 -0.1133E-01     1.990
    9    78   0.2680E-05 -0.1133E-01     2.005
   10    78   0.4075E-06 -0.1133E-01     2.021
   11    78   0.5333E-07 -0.1133E-01     2.037
   12    78   0.5709E-08 -0.1133E-01     2.052
   13    78   0.3866E-09 -0.1133E-01     2.068
   14    77  -0.3202E-10 -0.1133E-01     2.084
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a. Continued.

Figure 3. Continued.

PANEL SOURCE DISTRIBUTION NNE= 4 NL= 4 ML= 5

ICENP	X	Y	Z	S	GSX	GSY	GSZ	INTSDX
154	20.625000	3.349184	-4.101042	0.000673	-0.004678	0.018197	0.000000	0.001334
155	21.875000	3.349184	-4.101042	0.002715	0.002004	0.036497	0.000000	0.002146
156	23.125000	3.349184	-4.101042	0.005684	0.002745	0.076415	0.000000	0.007250
157	24.375000	3.349184	-4.101042	0.009578	-0.008922	0.111317	0.000000	0.019068
158	20.625000	1.913819	-4.101042	-0.007127	-0.017302	0.003399	0.000000	-0.001075
159	21.875000	1.913819	-4.101042	-0.028755	-0.021231	0.013714	0.000000	-0.022734
160	23.125000	1.913819	-4.101042	-0.060204	-0.029078	0.028712	0.000000	-0.076801
161	24.375000	1.913819	-4.101042	-0.101450	-0.032997	0.048383	0.000000	-0.177069
162	20.625000	0.615156	-4.101042	-0.004397	-0.012883	-0.007040	0.000000	-0.000232
163	21.875000	0.615156	-4.101042	-0.017740	-0.013098	-0.014119	0.000000	-0.014026
164	23.125000	0.615156	-4.101042	-0.037142	-0.017940	-0.029562	0.000000	-0.047381
165	24.375000	0.615156	-4.101042	-0.062589	-0.024571	-0.043064	0.000000	-0.108418

a. Continued.

Figure 3. Continued.

PANEL CENTER OUTPUT NNE= 2 NL= 5 ML=25

ICONP	IBCT	X	Y	Z	VX	VY	VZ	VXINT	VYINT	VZINT	CP	INTSDX
35	4	-6.000000	3.759274	-4.101042	0.988735	-0.000061	0.000007	-0.011237	-0.000064	-0.000011	0.022484	0.000000
36	4	-0.750000	3.759274	-4.101042	0.988911	-0.000135	0.000028	-0.011022	-0.000143	-0.000003	0.022132	0.000000
37	4	1.250000	3.759274	-4.101042	0.990384	-0.001011	0.002031	-0.009516	-0.001026	0.001993	0.019193	0.001395
38	4	2.800000	3.759274	-4.101042	0.992858	-0.002798	0.002162	-0.006998	-0.002822	0.002118	0.014253	0.004278
39	4	4.500000	3.759274	-4.101042	0.991381	-0.004886	0.001764	-0.008398	-0.004932	0.001716	0.017184	0.007440
40	4	6.300000	3.759274	-4.101042	0.985118	-0.003744	0.002503	-0.014520	-0.003845	0.002465	0.029662	0.010788
41	4	8.100000	3.759274	-4.101042	0.990392	-0.002007	0.003290	-0.009027	-0.002246	0.003310	0.019167	0.014136
42	4	9.800000	3.759274	-4.101042	0.991304	-0.003779	0.002644	-0.007966	-0.004297	0.002786	0.017343	0.017298
43	4	11.300000	3.759274	-4.101042	0.987567	-0.002634	0.003563	-0.011716	-0.003465	0.003734	0.024790	0.020088
44	4	12.500000	3.759274	-4.101042	0.993630	-0.002177	0.004286	-0.005495	-0.003328	0.004422	0.012702	0.022320
45	4	13.500000	3.759274	-4.101042	0.991899	-0.005431	0.003551	-0.007052	-0.006968	0.003753	0.016136	0.024180
46	4	14.500000	3.759274	-4.101042	0.983874	-0.004259	0.004019	-0.015078	-0.006202	0.004355	0.032121	0.026040
47	4	15.700000	3.759274	-4.101042	0.985100	-0.000572	0.005137	-0.014028	-0.002892	0.005606	0.029690	0.028272
48	4	17.300000	3.759274	-4.101042	0.992114	0.000653	0.005188	-0.007304	-0.001961	0.005753	0.015721	0.031248
49	4	19.100000	3.759274	-4.101042	0.993828	-0.001407	0.005689	-0.005842	-0.004164	0.006280	0.012295	0.034596
50	4	20.625000	3.759274	-4.101042	0.998579	-0.009807	0.010108	-0.001218	-0.012611	0.010693	0.002644	0.038767
51	4	21.875000	3.759274	-4.101042	0.994642	-0.023752	0.016985	-0.005218	-0.026574	0.017561	0.009850	0.041904
52	4	23.125000	3.759274	-4.101042	0.988735	-0.049403	0.031929	-0.011166	-0.052234	0.032495	0.019000	0.049333
53	4	24.375000	3.759274	-4.101042	1.009810	-0.069073	0.048758	0.009882	-0.071910	0.049316	-0.026750	0.063475
54	4	25.320000	3.759274	-4.101042	1.026770	0.028620	-0.035384	0.026827	0.025780	-0.034831	-0.055822	0.034421
55	4	25.960000	3.759274	-4.101042	0.974057	0.101497	-0.035267	-0.025894	0.098655	-0.034718	0.039920	0.012124
56	4	26.600000	3.759274	-4.101042	0.902910	0.142742	-0.035084	-0.097047	0.139899	-0.034537	0.167445	-0.010174
57	4	27.240000	3.759274	-4.101042	0.844171	0.135284	-0.036355	-0.155792	0.132440	-0.035811	0.279404	-0.032472
58	4	28.780000	3.759274	-4.101042	0.764422	0.089924	-0.035114	-0.235551	0.087078	-0.034575	0.433413	-0.086125
61	4	-6.000000	2.734013	-4.101042	0.988735	-0.000028	0.000003	-0.011237	-0.000030	-0.000016	0.022484	0.000000
62	4	-0.750000	2.734013	-4.101042	0.988956	-0.000055	0.000048	-0.010975	-0.000061	0.000016	0.022043	0.000000
63	4	1.250000	2.734013	-4.101042	0.990665	-0.000644	0.001972	-0.009231	-0.000655	0.001934	0.018634	0.001395
64	4	2.800000	2.734013	-4.101042	0.992747	-0.001696	0.001799	-0.007101	-0.001715	0.001756	0.014480	0.004278
65	4	4.500000	2.734013	-4.101042	0.991460	-0.000086	0.001692	-0.008301	-0.000122	0.001647	0.017050	0.007440
66	4	6.300000	2.734013	-4.101042	0.989456	-0.008884	0.001635	-0.010135	-0.008966	0.001606	0.020965	0.010788
67	4	8.100000	2.734013	-4.101042	0.990424	-0.017592	0.001708	-0.008871	-0.017805	0.001774	0.018804	0.014136
68	4	9.800000	2.734013	-4.101042	0.992131	-0.016402	0.001515	-0.006908	-0.016914	0.001827	0.015444	0.017298
69	4	11.300000	2.734013	-4.101042	0.992211	-0.025730	0.001406	-0.006820	-0.026600	0.001880	0.014888	0.020088
70	4	12.500000	2.734013	-4.101042	0.993761	-0.032325	0.001382	-0.004979	-0.033571	0.001947	0.011412	0.022320
71	4	13.500000	2.734013	-4.101042	0.992544	-0.031448	0.001053	-0.005934	-0.033162	0.001906	0.013897	0.024180
72	4	14.500000	2.734013	-4.101042	0.989283	-0.037683	0.001072	-0.009263	-0.039868	0.002289	0.019962	0.026040
73	4	15.700000	2.734013	-4.101042	0.989169	-0.050498	0.001067	-0.009696	-0.053091	0.002585	0.019052	0.028272
74	4	17.300000	2.734013	-4.101042	0.993275	-0.056815	0.001214	-0.006020	-0.059711	0.002932	0.010192	0.031248
75	4	19.100000	2.734013	-4.101042	0.998478	-0.068477	0.001008	-0.001148	-0.071504	0.002783	-0.001649	0.034596
76	4	20.625000	2.734013	-4.101042	1.000168	-0.082744	-0.004538	0.000389	-0.085811	-0.002764	-0.007194	0.038767
77	4	21.875000	2.734013	-4.101042	0.998265	-0.083167	-0.010349	-0.001586	-0.086250	-0.008583	-0.003554	0.041904
78	4	23.125000	2.734013	-4.101042	0.994861	-0.092927	-0.023386	-0.005035	-0.096018	-0.021628	0.001070	0.049333
79	4	24.375000	2.734013	-4.101042	0.980718	-0.088746	-0.036013	-0.019207	-0.091841	-0.034264	0.029155	0.063475
80	4	25.320000	2.734013	-4.101042	0.950500	0.024062	-0.035636	-0.049441	0.020965	-0.033892	0.096143	0.034421

a. Continued.

Figure 3. Continued.

SLOTTED WALL OUTPUT NNE= 3 NL= 5 ML=15

ICONP	BC	X	Y	Z	VX	VY	VZ	S	PHI	CP
164	1	2.800000	2.734000	-4.101042	0.992747	-0.001620	0.001799	-0.002961	-0.138332	0.014480
165	1	4.500000	2.734000	-4.101042	0.991460	-0.000581	0.001692	-0.006119	-0.151187	0.017050
166	1	6.300000	2.734000	-4.101042	0.989456	-0.007335	0.001635	-0.019954	-0.168839	0.020990
167	1	8.100000	2.734000	-4.101042	0.990424	-0.013928	0.001708	0.024056	-0.187895	0.018920
168	1	9.800000	2.734000	-4.101042	0.992131	-0.013151	0.001515	0.013214	-0.202028	0.015540
169	1	11.300000	2.734000	-4.101042	0.992211	-0.020521	0.001406	0.008369	-0.214221	0.015130
170	1	12.500000	2.734000	-4.101042	0.993761	-0.025860	0.001382	0.045599	-0.222765	0.011790
171	1	13.500000	2.734000	-4.101042	0.992544	-0.025449	0.001053	0.029638	-0.228882	0.014240
172	1	14.500000	2.734000	-4.101042	0.989283	-0.030246	0.001072	0.024419	-0.238278	0.020470
173	1	15.700000	2.734000	-4.101042	0.989169	-0.039850	0.001067	0.051586	-0.251891	0.020020
174	1	17.300000	2.734000	-4.101042	0.993275	-0.044433	0.001214	0.077193	-0.266819	0.011450
175	1	19.100000	2.734000	-4.101042	0.998479	-0.053286	0.001008	0.071073	-0.273311	0.000200
176	1	20.625000	2.734000	-4.101042	1.000168	-0.064087	-0.004538	0.091847	-0.274165	-0.004460
177	1	2.800000	1.367000	-4.101042	0.991900	0.003682	0.001747	-0.010626	-0.139510	0.016160
178	1	4.500000	1.367000	-4.101042	0.991132	0.005839	0.001967	-0.021961	-0.154125	0.017670
179	1	6.300000	1.367000	-4.101042	0.991323	0.009163	0.001676	-0.021453	-0.169863	0.017240
180	1	8.100000	1.367000	-4.101042	0.990263	0.011641	0.001448	-0.057817	-0.186645	0.019300
181	1	9.800000	1.367000	-4.101042	0.991659	0.013845	0.001714	-0.051029	-0.202501	0.016460
182	1	11.300000	1.367000	-4.101042	0.993061	0.018906	0.001302	-0.068434	-0.213668	0.013500
183	1	12.500000	1.367000	-4.101042	0.992518	0.023873	0.001140	-0.098107	-0.222239	0.014370
184	1	13.500000	1.367000	-4.101042	0.991789	0.026868	0.001337	-0.108446	-0.230248	0.015670
185	1	14.500000	1.367000	-4.101042	0.991674	0.029492	0.001270	-0.117390	-0.238698	0.015750
186	1	15.700000	1.367000	-4.101042	0.991446	0.031856	0.000732	-0.137088	-0.248623	0.016060
187	1	17.300000	1.367000	-4.101042	0.993970	0.032894	0.001081	-0.158434	-0.261801	0.010960
188	1	19.100000	1.367000	-4.101042	1.000803	0.036647	0.000898	-0.156768	-0.265695	-0.002950
189	1	20.625000	1.367000	-4.101042	1.005554	0.038875	-0.006736	-0.228825	-0.262057	-0.012670
190	1	2.800000	0.000000	-4.101042	0.990875	0.000000	0.005374	0.000523	-0.141836	0.018190
191	1	4.500000	0.000000	-4.101042	0.990254	0.000000	0.007490	0.001081	-0.157751	0.019400
192	1	6.300000	0.000000	-4.101042	0.989742	0.000000	0.011724	0.004943	-0.175736	0.020340
193	1	8.100000	0.000000	-4.101042	0.989698	0.000000	0.014929	0.009734	-0.194232	0.020340
194	1	9.800000	0.000000	-4.101042	0.989986	0.000000	0.017289	0.011486	-0.211489	0.019690
195	1	11.300000	0.000000	-4.101042	0.990132	0.000000	0.023155	0.013763	-0.226122	0.019160
196	1	12.500000	0.000000	-4.101042	0.989968	0.000000	0.028857	0.022018	-0.237990	0.019190
197	1	13.500000	0.000000	-4.101042	0.989771	0.000000	0.031977	0.026460	-0.247966	0.019390
198	1	14.500000	0.000000	-4.101042	0.989733	0.000000	0.035452	0.024284	-0.258276	0.019230
199	1	15.700000	0.000000	-4.101042	0.990347	0.000000	0.039147	0.028323	-0.270041	0.017730
200	1	17.300000	0.000000	-4.101042	0.993121	0.000000	0.041644	0.023016	-0.284168	0.012000
201	1	19.100000	0.000000	-4.101042	0.998966	0.000000	0.047502	0.024165	-0.290803	-0.000190
202	1	20.625000	0.000000	-4.101042	1.005902	0.000000	0.046509	0.004301	-0.289251	-0.013970

a. Continued.

Figure 3. Continued.

X (S)	S AVG
2.000000	-0.004355
3.600000	-0.009000
5.400000	-0.012154
7.200000	-0.008009
9.000000	-0.008776
10.600000	-0.015434
12.000000	-0.010163
13.000000	-0.017449
14.000000	-0.022896
15.000000	-0.019060
16.400000	-0.019409
18.200000	-0.020510
20.000000	-0.044225

TOTAL SLOT FLUX = -1.279751

a. Continued.

Figure 3. Continued.

```
FIELD POINTS USED FOR MODEL=        70

FIELD ROW INPUT DATA IN TUNNEL COORDINATES

NROW=  10

 IROW=   1  NPROW=  55     X1,Y1,Z1=  -0.05000   4.10100   0.00000     X2,Y2,Z2=  26.95000   4.10100   0.00000
 IROW=   2  NPROW=  55     X1,Y1,Z1=   0.00000   2.05050   0.00000     X2,Y2,Z2=  27.00000   2.05050   0.00000
 IROW=   3  NPROW=  11     X1,Y1,Z1=  12.61541   0.00000  -0.15995     X2,Y2,Z2=  13.93634   2.50000  -0.00136
 IROW=   4  NPROW=  11     X1,Y1,Z1=  14.47490   0.00000  -0.06647     X2,Y2,Z2=  15.09772   1.00000   0.08194
 IROW=   5  NPROW=  23     X1,Y1,Z1=   9.99497   0.00000  -0.04185     X2,Y2,Z2=  15.48939   0.00000  -0.28947
 IROW=   6  NPROW=  23     X1,Y1,Z1=   9.99693   0.50000   0.00171     X2,Y2,Z2=  15.49135   0.50000  -0.24592
 IROW=   7  NPROW=  23     X1,Y1,Z1=   9.99889   1.00000   0.04526     X2,Y2,Z2=  15.49332   1.00000  -0.20236
 IROW=   8  NPROW=  23     X1,Y1,Z1=  10.00086   1.50000   0.08882     X2,Y2,Z2=  15.49528   1.50000  -0.15880
 IROW=   9  NPROW=  23     X1,Y1,Z1=  10.00282   2.00000   0.13237     X2,Y2,Z2=  15.49724   2.00000  -0.11525
 IROW=  10  NPROW=  23     X1,Y1,Z1=  10.00478   2.50000   0.17583     X2,Y2,Z2=  15.49920   2.50000  -0.07179

 TOTAL NO. OF FIELD POINTS=       340

MODEL CORRECTIONS

          CORRECTION                        STING INTERFERENCE
        TO               FOR                 INCLUDED     EXCLUDED

       CD             BUOYANCY               0.00018     -0.00052

       ALPHA DEG      UPWASH AT WING        -0.0776      -0.0814
       MACH           BLOCKAGE AT WING      -0.00561     -0.00371
       CD             UPWASH AT WING        -0.00076     -0.00079
       CM             UPWASH SPANWISE DIST   0.00050      0.00047
       CL             STREAMLINE CURVATURE  -0.00075     -0.00068
       CM             STREAMLINE CURVATURE   0.00014      0.00013

       TAIL INCID DEG UPWASH (TAIL-WING)     0.0484       0.0373
       MACH           BLOCKAGE AT TAIL      -0.00676     -0.00303
```

a. Continued.

Figure 3. Continued.

FIELD POINT DATA IROW=10 NPROW=23

POINT	X	Y	Z	VX	VY	VZ	VXINT	VYINT	VZINT	CP	DELM	DALPH
1	10.004779	2.500000	0.175829	0.990271	0.000986	-0.001501	-0.007948	-0.001173	-0.002371	0.019421	-0.007156	-0.135872
2	10.254526	2.500000	0.164573	0.990828	0.001479	-0.001357	-0.007671	-0.001176	-0.002367	0.018309	-0.006907	-0.135600
3	10.504272	2.500000	0.153318	0.991678	0.001949	-0.001170	-0.007393	-0.001173	-0.002345	0.016613	-0.006657	-0.134335
4	10.754019	2.500000	0.142063	0.992823	0.002290	-0.000932	-0.007118	-0.001162	-0.002305	0.014329	-0.006409	-0.132072
5	11.003765	2.500000	0.130807	0.994160	0.002406	-0.000635	-0.006849	-0.001141	-0.002249	0.011661	-0.006167	-0.128883
6	11.253512	2.500000	0.119552	0.995511	0.002257	-0.000264	-0.006591	-0.001106	-0.002180	0.008966	-0.005936	-0.124885
7	11.503258	2.500000	0.108296	0.996703	0.001885	0.000201	-0.006353	-0.001057	-0.002098	0.006586	-0.005721	-0.120194
8	11.753004	2.500000	0.097041	0.997651	0.001371	0.000792	-0.006143	-0.000991	-0.002005	0.004694	-0.005532	-0.114896
9	12.002751	2.500000	0.085785	0.998356	0.000791	0.001549	-0.005969	-0.000912	-0.001903	0.003284	-0.005376	-0.109050
10	12.252497	2.500000	0.074530	0.998862	0.000187	0.002529	-0.005839	-0.000822	-0.001793	0.002269	-0.005259	-0.102703
11	12.502244	2.500000	0.063274	0.999245	-0.000413	0.003819	-0.005756	-0.000727	-0.001674	0.001496	-0.005184	-0.095887
12	12.751990	2.500000	0.052019	0.999677	-0.001030	0.005554	-0.005723	-0.000630	-0.001546	0.000614	-0.005154	-0.088594
13	13.001737	2.500000	0.040763	1.000376	-0.001851	0.007956	-0.005740	-0.000535	-0.001410	-0.000818	-0.005170	-0.080798
14	13.251483	2.500000	0.029508	1.001373	-0.003227	0.011439	-0.005810	-0.000446	-0.001265	-0.002888	-0.005233	-0.072478
15	13.501230	2.500000	0.018252	1.002602	-0.005683	0.016806	-0.005928	-0.000368	-0.001111	-0.005520	-0.005339	-0.063629
16	13.750976	2.500000	0.006997	0.998302	-0.011994	0.024590	-0.006091	-0.000302	-0.000947	0.002645	-0.005486	-0.054240
17	14.000723	2.500000	-0.004259	0.996703	-0.026581	0.028857	-0.006291	-0.000248	-0.000774	0.005047	-0.005665	-0.044323
18	14.250469	2.500000	-0.015514	0.991698	-0.020500	0.035466	-0.006519	-0.000205	-0.000592	0.014891	-0.005870	-0.033921
19	14.500216	2.500000	-0.026770	0.992079	-0.018042	0.038466	-0.006767	-0.000168	-0.000403	0.014006	-0.006093	-0.023097
20	14.749962	2.500000	-0.038025	0.992107	-0.016335	0.040589	-0.007024	-0.000132	-0.000208	0.013839	-0.006325	-0.011908
21	14.999709	2.500000	-0.049281	0.991832	-0.014725	0.042343	-0.007281	-0.000085	-0.000007	0.014291	-0.006556	-0.000420
22	15.249455	2.500000	-0.060536	0.991396	-0.012980	0.043865	-0.007530	-0.000018	0.000197	0.015078	-0.006780	0.011286
23	15.499202	2.500000	-0.071792	0.990975	-0.011028	0.045197	-0.007765	0.000080	0.000403	0.015844	-0.006991	0.023118

PROCESS	START	INPUT	SFIT	PICF	MATA	SOLVE	PCOUT	FIELD
TIME=	0.1	0.5	4.0	4.7	20.5	22.6	24.1	33.7
DTIME=	0.0	0.4	3.6	0.7	15.8	2.1	1.5	9.6
PETIME=	0.0	1.2	10.6	1.9	47.0	6.3	4.5	28.5

a. Concluded.

Figure 3. Continued.

INPUT NETWORK DEFINING POINT DATA BELOW

NETWORK	N	M	IDEFP	PDEFP(X)	PDEFP(Y)	PDEFP(Z)
1	1	1	1	-10.00000000	4.10104200	-4.10104200
1	1	2	2	-10.00000000	0.00000000	-4.10104200
1	2	1	3	-10.00000000	4.10104200	4.10104200
1	2	2	4	-10.00000000	0.00000000	4.10104200
2	1	1	5	-10.00000000	4.10104200	-4.10104200
2	1	2	6	-2.00000000	4.10104200	-4.10104200
2	1	3	7	0.50000000	4.10104200	-4.10104200
2	1	4	8	2.00000000	4.10104200	-4.10104200
2	1	5	9	3.60000000	4.10104200	-4.10104200
2	1	6	10	5.40000000	4.10104200	-4.10104200
2	1	7	11	7.20000000	4.10104200	-4.10104200
2	1	8	12	9.00000000	4.10104200	-4.10104200
2	1	9	13	10.60000000	4.10104200	-4.10104200
2	1	10	14	12.00000000	4.10104200	-4.10104200
2	1	11	15	13.00000000	4.10104200	-4.10104200
2	1	12	16	14.00000000	4.10104200	-4.10104200
2	1	13	17	15.00000000	4.10104200	-4.10104200
2	1	14	18	16.40000000	4.10104200	-4.10104200
2	1	15	19	18.20000000	4.10104200	-4.10104200
2	1	16	20	20.00000000	4.10104200	-4.10104200
2	1	17	21	21.25000000	4.10104200	-4.10104200
2	1	18	22	22.50000000	4.10104200	-4.10104200
2	1	19	23	23.75000000	4.10104200	-4.10104200
2	1	20	24	25.00000000	4.10104200	-4.10104200
2	1	21	25	25.64000000	4.10104200	-4.10104200
2	1	22	26	26.28000000	4.10104200	-4.10104200
2	1	23	27	26.92000000	4.10104200	-4.10104200
2	1	24	28	27.56000000	4.10104200	-4.10104200
2	1	25	29	30.00000000	4.10104200	-4.10104200
2	2	1	30	-10.00000000	3.41750500	-4.10104200
2	2	2	31	-2.00000000	3.41750500	-4.10104200
2	2	3	32	0.50000000	3.41750500	-4.10104200

b. Additional geometry output, MOVE(1)=2 or 4.

Figure 3. Continued.

PANEL SINGULARITY FIT DATA NNE= 4 NL= 4 ML= 5 IST= 6 IDT= 0

N	M	NPB	X	Y	Z	XN	YN	ZN	AREA	NNN1	NNN2
1	1	4	20.62500	2.01187	-2.46352	0.00000	0.00000	1.00000	1.129	2	0
1	2	4	21.87500	2.01187	-2.46352	0.00000	0.00000	1.00000	1.129	2	0
1	3	4	23.12500	2.01187	-2.46352	0.00000	0.00000	1.00000	1.129	2	0
1	4	4	24.37500	2.01187	-2.46352	0.00000	0.00000	1.00000	1.129	2	0
2	1	4	20.62500	1.14964	-2.46352	0.00000	0.00000	1.00000	1.026	3	0
2	2	4	21.87500	1.14964	-2.46352	0.00000	0.00000	1.00000	1.026	3	0
2	3	4	23.12500	1.14964	-2.46352	0.00000	0.00000	1.00000	1.026	3	0
2	4	4	24.37500	1.14964	-2.46352	0.00000	0.00000	1.00000	1.026	3	0
3	1	4	20.62500	0.36953	-2.46352	0.00000	0.00000	1.00000	0.924	2	0
3	2	4	21.87500	0.36953	-2.46352	0.00000	0.00000	1.00000	0.924	2	0
3	3	4	23.12500	0.36953	-2.46352	0.00000	0.00000	1.00000	0.924	2	0
3	4	4	24.37500	0.36953	-2.46352	0.00000	0.00000	1.00000	0.924	2	0

NETWORK AREA SUMMATION= 0.123176E+02

b. Continued.

Figure 3. Continued.

FINAL CONTROL POINT DATA FOR AIC SPECIFICATION

ICONP	IBCT	FP(X)	FP(Y)	FP(Z)	BCONP
1	6	0.243750000000E+02	0.334918400000E+01	-0.410104100000E+01	0.000000000000E+00
2	6	0.243750000000E+02	0.191381950000E+01	-0.410104100000E+01	0.000000000000E+00
3	6	0.243750000000E+02	0.615156500000E+00	-0.410104100000E+01	0.000000000000E+00
4	6	0.243750000000E+02	0.615156500000E+00	0.410104100000E+01	0.000000000000E+00
5	6	0.243750000000E+02	0.191381950000E+01	0.410104100000E+01	0.000000000000E+00
6	6	0.243750000000E+02	0.334918400000E+01	0.410104100000E+01	0.000000000000E+00
7	4	-0.100000010000E+02	0.205052100000E+01	0.000000000000E+00	0.000000000000E+00
8	4	-0.999960000000E+01	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
9	4	-0.600000000000E+01	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
10	4	-0.750000000000E+00	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
11	4	0.125000000000E+01	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
12	4	0.280000000000E+01	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
13	4	0.450000000000E+01	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
14	4	0.630000000000E+01	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
15	4	0.810000000000E+01	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
16	4	0.980000000000E+01	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
17	4	0.113000000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
18	4	0.125000000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
19	4	0.135000000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
20	4	0.145000000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
21	4	0.157000000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
22	4	0.173000000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
23	4	0.191000000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
24	4	0.206250000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
25	4	0.218750000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
26	4	0.231250000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
27	4	0.243750000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
28	4	0.253200000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
29	4	0.259600000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
30	4	0.266000000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00
31	4	0.272400000000E+02	0.410100782315E+01	-0.410104300000E+01	0.000000000000E+00

b. Continued.

Figure 3. Continued.

```
                                                      MLWD,LPF=        0       0
NNE,ISF,NS,ND,IJF,NFP=   1    1    1    1   -1   581  MLWD,LPF=     2324       0
NNE,ISF,NS,ND,IJF,NFP=   2    2    1    6   -1   581  MLWD,LPF=   364868       5
NNE,ISF,NS,ND,IJF,NFP=   3    1    3    1   -1   581  MLWD,LPF=   455504       7
NNE,ISF,NS,ND,IJF,NFP=   4    1    3    1   -1   581  MLWD,LPF=   462476       7
NNE,ISF,NS,ND,IJF,NFP=   5    1    1    1   -1   581  MLWD,LPF=   467124       7
NNE,ISF,NS,ND,IJF,NFP=   6    2    1    6   -1   581  MLWD,LPF=   890092      13
NNE,ISF,NS,ND,IJF,NFP=   7    1    3    1   -1   581  MLWD,LPF=   904036      13
NNE,ISF,NS,ND,IJF,NFP=   8    1    3    1   -1   581  MLWD,LPF=   915656      14
NNE,ISF,NS,ND,IJF,NFP=   9    2    1    6   -1   581  MLWD,LPF=  1278200      19
NNE,ISF,NS,ND,IJF,NFP=  10    1    3    1   -1   581  MLWD,LPF=  1368836      21
NNE,ISF,NS,ND,IJF,NFP=  11    1    3    1   -1   581  MLWD,LPF=  1375808      21
NNE,ISF,NS,ND,IJF,NFP=  12    1    1    1   -1   581  MLWD,LPF=  1380456      21
NETWORK NO.  13  PANEL NO.   1  IJF=-1  IJFSUM=  52
NNE,ISF,NS,ND,IJF,NFP=  13    1    1    1   -1   581  MLWD,LPF=  1382780      21
NNE,ISF,NS,ND,IJF,NFP=  14    3    1    1   -1   581  MLWD,LPF=  1392076      21

SMOOTHING IN "A" MATRIX

          NO. OF
    NNE   COLUMNS      FSN        FSM
```

b. Concluded.

Figure 3. Continued.

```
NRM=   581   SOLUTION VECTOR BELOW
 0.19762E-01 -0.20933E+00 -0.12915E+00 -0.43463E-01 -0.18588E+00 -0.44561E-01 -0.11333E-01 -0.10964E-03 -0.45320E-01 -0.10422E+00
-0.12642E+00 -0.13884E+00 -0.15033E+00 -0.17290E+00 -0.19694E+00 -0.20984E+00 -0.22722E+00 -0.23937E+00 -0.24426E+00 -0.25697E+00
-0.27776E+00 -0.29584E+00 -0.30725E+00 -0.31589E+00 -0.32243E+00 -0.33791E+00 -0.35532E+00 -0.30090E+00 -0.28540E+00 -0.31417E+00
-0.40112E+00 -0.71792E+00 -0.10595E+01 -0.73716E-04 -0.45304E-01 -0.10419E+00 -0.12636E+00 -0.13873E+00 -0.15031E+00 -0.17258E+00
-0.19632E+00 -0.20930E+00 -0.22637E+00 -0.23828E+00 -0.24322E+00 -0.25575E+00 -0.27613E+00 -0.29402E+00 -0.30508E+00 -0.31245E+00
-0.31841E+00 -0.33209E+00 -0.34860E+00 -0.30724E+00 -0.30754E+00 -0.34562E+00 -0.42927E+00 -0.73595E+00 -0.10617E+01 -0.60993E-04
-0.45282E-01 -0.10415E+00 -0.12594E+00 -0.13756E+00 -0.14984E+00 -0.16763E+00 -0.18702E+00 -0.20061E+00 -0.21279E+00 -0.22118E+00
-0.22642E+00 -0.23584E+00 -0.24999E+00 -0.26505E+00 -0.27041E+00 -0.27111E+00 -0.27391E+00 -0.27601E+00 -0.28907E+00 -0.32371E+00
-0.36187E+00 -0.42139E+00 -0.50690E+00 -0.79206E+00 -0.10846E+01 -0.52972E-04 -0.45269E-01 -0.10416E+00 -0.12638E+00 -0.13890E+00
-0.15332E+00 -0.16880E+00 -0.18543E+00 -0.20113E+00 -0.21184E+00 -0.22008E+00 -0.22771E+00 -0.23581E+00 -0.24526E+00 -0.25820E+00
-0.26034E+00 -0.25628E+00 -0.25015E+00 -0.23910E+00 -0.24630E+00 -0.34666E+00 -0.41643E+00 -0.50044E+00 -0.59878E+00 -0.87064E+00
-0.11248E+01 -0.50661E-04 -0.45265E-01 -0.10416E+00 -0.12718E+00 -0.14129E+00 -0.15706E+00 -0.17482E+00 -0.19317E+00 -0.21027E+00
-0.22445E+00 -0.23604E+00 -0.24564E+00 -0.25557E+00 -0.26679E+00 -0.28057E+00 -0.28535E+00 -0.28170E+00 -0.27511E+00 -0.26668E+00
-0.28088E+00 -0.36251E+00 -0.44087E+00 -0.55189E+00 -0.66717E+00 -0.93627E+00 -0.11481E+01 -0.50509E-04 -0.45265E-01 -0.10415E+00
-0.12733E+00 -0.14178E+00 -0.15783E+00 -0.17617E+00 -0.19496E+00 -0.21239E+00 -0.22739E+00 -0.23975E+00 -0.24978E+00 -0.26018E+00
-0.27192E+00 -0.28600E+00 -0.29156E+00 -0.28822E+00 -0.28182E+00 -0.27437E+00 -0.28986E+00 -0.36534E+00 -0.44436E+00 -0.56094E+00
-0.67988E+00 -0.94908E+00 -0.11504E+01 -0.29608E-02 -0.61191E-02 -0.19954E-01  0.24056E-01  0.13214E-01  0.83686E-02  0.45599E-01
 0.29638E-01  0.24419E-01  0.51586E-01  0.77193E-01  0.71073E-01  0.91847E-01 -0.10626E-01 -0.21961E-01 -0.21453E-01 -0.57817E-01
-0.51029E-01 -0.68434E-01 -0.98107E-01 -0.10845E+00 -0.11739E+00 -0.13709E+00 -0.15843E+00 -0.15677E+00 -0.22883E+00  0.52282E-03
 0.10805E-02  0.49433E-02  0.97342E-02  0.11486E-01  0.13763E-01  0.22018E-01  0.26460E-01  0.24284E-01  0.28323E-01  0.23016E-01
 0.24165E-01  0.43012E-02  0.21068E-04 -0.45186E-01 -0.10508E+00 -0.13808E+00 -0.16965E+00 -0.19538E+00 -0.21385E+00 -0.23046E+00
-0.24498E+00 -0.25162E+00 -0.25195E+00 -0.25195E+00 -0.26106E+00 -0.26365E+00 -0.26157E+00 -0.26830E+00 -0.26306E+00 -0.25024E+00
-0.24146E+00 -0.23966E+00 -0.21411E+00 -0.20489E+00 -0.23497E+00 -0.32195E+00 -0.63669E+00 -0.98319E+00  0.16558E-04 -0.45199E-01
-0.10510E+00 -0.13231E+00 -0.15462E+00 -0.17543E+00 -0.19424E+00 -0.21257E+00 -0.22845E+00 -0.23603E+00 -0.23717E+00 -0.23756E+00
-0.24102E+00 -0.24440E+00 -0.24757E+00 -0.25126E+00 -0.24760E+00 -0.24152E+00 -0.23875E+00 -0.24499E+00 -0.24028E+00 -0.23239E+00
-0.26255E+00 -0.34948E+00 -0.66590E+00 -0.10032E+01  0.56394E-05 -0.45216E-01 -0.10471E+00 -0.12789E+00 -0.14520E+00 -0.16312E+00
-0.18175E+00 -0.20052E+00 -0.21687E+00 -0.22595E+00 -0.22790E+00 -0.22783E+00 -0.22943E+00 -0.23466E+00 -0.24324E+00 -0.25029E+00
-0.25430E+00 -0.25825E+00 -0.26643E+00 -0.28337E+00 -0.28514E+00 -0.27756E+00 -0.30687E+00 -0.39307E+00 -0.70572E+00 -0.10222E+01
-0.11857E-04 -0.45232E-01 -0.10434E+00 -0.12622E+00 -0.14215E+00 -0.15904E+00 -0.17734E+00 -0.19601E+00 -0.21269E+00 -0.22361E+00
-0.22823E+00 -0.23109E+00 -0.23571E+00 -0.24436E+00 -0.25689E+00 -0.26785E+00 -0.27706E+00 -0.28654E+00 -0.30008E+00 -0.32076E+00
-0.32306E+00 -0.31484E+00 -0.34323E+00 -0.42850E+00 -0.73773E+00 -0.10475E+01 -0.33683E-04 -0.45253E-01 -0.10415E+00 -0.12549E+00
-0.14037E+00 -0.15616E+00 -0.17436E+00 -0.19315E+00 -0.20955E+00 -0.22203E+00 -0.23015E+00 -0.23726E+00 -0.24596E+00 -0.25770E+00
-0.27227E+00 -0.28414E+00 -0.29372E+00 -0.30351E+00 -0.31734E+00 -0.33764E+00 -0.33918E+00 -0.33082E+00 -0.35937E+00 -0.44489E+00
-0.75495E+00 -0.10660E+01 -0.60337E-04 -0.45287E-01 -0.10415E+00 -0.12562E+00 -0.13899E+00 -0.15264E+00 -0.17215E+00 -0.19269E+00
-0.20757E+00 -0.22174E+00 -0.23178E+00 -0.23893E+00 -0.24945E+00 -0.26473E+00 -0.28076E+00 -0.29137E+00 -0.29834E+00 -0.30531E+00
-0.31719E+00 -0.33274E+00 -0.32069E+00 -0.30890E+00 -0.33770E+00 -0.42415E+00 -0.73876E+00 -0.10620E+01 -0.10879E-03 -0.45320E-01
-0.10422E+00 -0.12642E+00 -0.13884E+00 -0.15033E+00 -0.17290E+00 -0.19694E+00 -0.20984E+00 -0.22722E+00 -0.23937E+00 -0.24426E+00
-0.25697E+00 -0.27776E+00 -0.29584E+00 -0.30726E+00 -0.31589E+00 -0.32243E+00 -0.33791E+00 -0.35532E+00 -0.30090E+00 -0.28540E+00
-0.31417E+00 -0.40112E+00 -0.71792E+00 -0.10597E+01  0.26403E-04 -0.45201E-01 -0.10476E+00 -0.12918E+00 -0.14528E+00 -0.16245E+00
-0.18168E+00 -0.20076E+00 -0.21629E+00 -0.22484E+00 -0.22839E+00 -0.22924E+00 -0.22907E+00 -0.22915E+00 -0.23194E+00 -0.23129E+00
-0.22673E+00 -0.22276E+00 -0.22455E+00 -0.24766E+00 -0.28120E+00 -0.34999E+00 -0.46434E+00 -0.58340E+00 -0.85442E+00 -0.10576E+01
 0.26378E-04 -0.45198E-01 -0.10474E+00 -0.12831E+00 -0.14269E+00 -0.15888E+00 -0.17812E+00 -0.19775E+00 -0.21425E+00 -0.22271E+00
-0.22602E+00 -0.22690E+00 -0.22597E+00 -0.22641E+00 -0.22988E+00 -0.22785E+00 -0.22189E+00 -0.21669E+00 -0.21596E+00 -0.23601E+00
-0.27873E+00 -0.34724E+00 -0.45608E+00 -0.57147E+00 -0.84234E+00 -0.10558E+01  0.25991E-04 -0.45198E-01 -0.10481E+00 -0.12547E+00
-0.13362E+00 -0.14630E+00 -0.16565E+00 -0.18750E+00 -0.20785E+00 -0.21583E+00 -0.21797E+00 -0.21900E+00 -0.21540E+00 -0.21747E+00
-0.22366E+00 -0.21605E+00 -0.20417E+00 -0.19338E+00 -0.18137E+00 -0.18748E+00 -0.26331E+00 -0.32679E+00 -0.40945E+00 -0.50798E+00
-0.78175E+00 -0.10389E+01  0.24383E-04 -0.45197E-01 -0.10502E+00 -0.13030E+00 -0.14681E+00 -0.16416E+00 -0.18314E+00 -0.20355E+00
```

c. Additional solution output, MOVE(1)=3 or 4.

Figure 3. Continued.

FLOW AT CONTROL POINTS

ICONP	IBCT	VX	VY	VZ	VXINT	VYINT	VZINT	PHI
1	6	1.003464	-0.080049	-0.010434	0.003538	-0.083049	-0.009455	-0.326158
2	6	0.952980	0.002065	-0.091684	-0.046943	-0.000728	-0.088758	-0.248264
3	6	0.958135	0.039502	-0.068590	-0.041786	0.038372	-0.064187	-0.271190
4	6	0.969675	0.051971	0.027025	-0.030331	0.052986	0.031112	-0.223194
5	6	0.962482	0.018587	0.079844	-0.037525	0.021117	0.082633	-0.178665
6	6	1.002658	-0.061398	0.036969	0.002650	-0.058611	0.038013	-0.221959
7	4	1.000018	-0.000003	0.000002	0.000031	-0.000004	-0.000013	0.000008
8	4	1.000011	-0.000018	0.000132	0.000028	-0.000019	0.000118	0.000007
9	4	1.000001	-0.000056	0.000097	0.000029	-0.000059	0.000078	0.000013
10	4	1.000049	-0.000137	0.000218	0.000115	-0.000146	0.000186	0.000037
11	4	1.000120	0.001420	-0.000502	0.000219	0.001405	-0.000540	-0.000062
12	4	0.999677	0.004482	-0.002085	-0.000182	0.004456	-0.002129	-0.000282
13	4	1.000545	0.013134	-0.005228	0.000759	0.013085	-0.005276	-0.000663
14	4	1.000065	-0.001802	-0.001372	0.000411	-0.001906	-0.001413	-0.000230
15	4	1.000498	-0.018328	0.003246	0.001039	-0.018570	0.003252	0.000291
16	4	1.000224	-0.010260	0.000287	0.000886	-0.010766	0.000383	-0.000085
17	4	1.000428	-0.026201	0.004236	0.001071	-0.026998	0.004331	0.000352
18	4	1.000184	-0.036477	0.006723	0.000951	-0.037566	0.006756	0.000599
19	4	0.999924	-0.026004	0.002530	0.000838	-0.027440	0.002581	0.000001
20	4	1.001327	-0.036672	0.005296	0.002255	-0.038478	0.005426	0.000302
21	4	1.000687	-0.062596	0.012770	0.001476	-0.064755	0.012989	0.001161
22	4	1.000602	-0.072207	0.015678	0.001143	-0.074648	0.015965	0.001391
23	4	1.000095	-0.079119	0.016352	0.000409	-0.081701	0.016656	0.001196
24	4	1.001737	-0.070934	0.016583	0.001933	-0.073564	0.016879	0.000537
25	4	1.001555	-0.046961	0.009502	0.001691	-0.049611	0.009788	0.000541
26	4	1.002335	-0.018940	0.001633	0.002432	-0.021600	0.001910	0.000717
27	4	0.993014	0.009775	-0.008759	-0.006915	0.007109	-0.008490	0.000739
28	4	0.993847	-0.011725	0.004706	-0.006096	-0.014394	0.004969	0.000191
29	4	1.000984	-0.001893	0.001249	0.001033	-0.004564	0.001510	0.000094
30	4	1.000566	-0.001525	0.001108	0.000609	-0.004197	0.001366	0.000068
31	4	0.998361	-0.001005	0.003001	-0.001602	-0.003678	0.003256	0.000056
32	4	1.002315	-0.005261	0.008918	0.002342	-0.007935	0.009168	0.000038
33	4	0.936579	-0.046113	0.070902	-0.063399	-0.048788	0.071149	0.000029
34	4	1.000016	0.000035	-0.000006	0.000032	0.000033	-0.000019	0.000007

c. Continued.

Figure 3. Continued.

PANEL CENTER OUTPUT NNE= 2 NL= 5 ML=25

ICONP / ICENP	IBCT	X / D	Y / GDX	Z / GDY	VX / GDZ	VY / S	VZ / GSX	VXINT / GSY	VYINT / GSZ	VZINT / PHI	CP	INTSDX
35	4	-6.000000	3.759274	-4.101042	0.988735	-0.000061	0.000007	-0.011237	-0.000064	-0.000011	0.022484	0.000000
2		-0.045304	-0.011269	-0.000060	0.000000	0.000000	0.000000	0.000000	0.000000	-0.045291		
36	4	-0.750000	3.759274	-4.101042	0.988911	-0.000135	0.000028	-0.011022	-0.000143	-0.000003	0.022132	0.000000
3		-0.104185	-0.011135	-0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	-0.104145		
37	4	1.250000	3.759274	-4.101042	0.990384	-0.001011	0.002031	-0.009516	-0.001026	0.001993	0.019193	0.001395
4		-0.126360	-0.009790	-0.000674	0.000000	0.002402	0.000722	0.000000	0.000000	-0.126407		
38	4	2.800000	3.759274	-4.101042	0.992858	-0.002798	0.002162	-0.006998	-0.002822	0.002118	0.014253	0.004278
5		-0.138730	-0.006794	-0.001823	0.000000	0.003521	0.000722	0.000000	0.000000	-0.138978		
39	4	4.500000	3.759274	-4.101042	0.991381	-0.004886	0.001764	-0.008398	-0.004932	0.001716	0.017184	0.007440
6		-0.150306	-0.009567	-0.000776	0.000000	0.006628	0.002811	0.000000	0.000000	-0.150739		
40	4	6.300000	3.759274	-4.101042	0.985118	-0.003744	0.002503	-0.014520	-0.003845	0.002465	0.029662	0.010788
7		-0.172580	-0.013340	-0.006160	0.000000	0.001110	-0.008942	0.000001	0.000000	-0.173061		
41	4	8.100000	3.759274	-4.101042	0.990392	-0.002007	0.003290	-0.009027	-0.002246	0.003310	0.019167	0.014136
8		-0.196318	-0.010439	-0.011397	0.000000	-0.004955	0.002203	0.000002	0.000000	-0.196778		
42	4	9.800000	3.759274	-4.101042	0.991304	-0.003779	0.002644	-0.007966	-0.004297	0.002786	0.017343	0.017298
9		-0.209305	-0.008989	-0.010143	0.000000	-0.002086	0.001108	0.000002	0.000000	-0.209959		
43	4	11.300000	3.759274	-4.101042	0.987567	-0.002634	0.003563	-0.011716	-0.003465	0.003734	0.024790	0.020088
10		-0.226368	-0.011096	-0.016206	0.000000	-0.008009	-0.009726	0.000003	0.000000	-0.227125		
44	4	12.500000	3.759274	-4.101042	0.993630	-0.002177	0.004286	-0.005495	-0.003328	0.004422	0.012702	0.022320
11		-0.238285	-0.007228	-0.020630	0.000000	-0.011898	0.005838	0.000003	0.000000	-0.239165		
45	4	13.500000	3.759274	-4.101042	0.991899	-0.005431	0.003551	-0.007052	-0.006968	0.003753	0.016136	0.024180
12		-0.243223	-0.008126	-0.020073	0.000000	-0.008025	0.001909	0.000003	0.000000	-0.244490		
46	4	14.500000	3.759274	-4.101042	0.983874	-0.004259	0.004019	-0.015078	-0.006202	0.004355	0.032121	0.026040
13		-0.255747	-0.015836	-0.023623	0.000000	-0.012038	-0.009936	0.000004	0.000000	-0.257065		
47	4	15.700000	3.759274	-4.101042	0.985100	-0.000572	0.005137	-0.014028	-0.002892	0.005606	0.029690	0.028272
14		-0.276131	-0.014458	-0.030862	0.000000	-0.021689	-0.006690	0.000005	0.000000	-0.277376		
48	4	17.300000	3.759274	-4.101042	0.992114	0.000653	0.005188	-0.007304	-0.001961	0.005753	0.015721	0.031248
15		-0.294022	-0.008562	-0.033488	0.000000	-0.025253	0.001243	0.000005	0.000000	-0.295334		
49	4	19.100000	3.759274	-4.101042	0.993828	-0.001407	0.005689	-0.005842	-0.004164	0.006280	0.012295	0.034596
16		-0.305085	-0.005092	-0.039687	0.000000	-0.027933	-0.004221	0.000006	0.000000	-0.306985		

c. Concluded.

Figure 3. Concluded.

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15. Supplementary Notes

NASA Langley Technical Monitor: Jerry B. Adcock

16. Abstract

Guidelines are presented for use of the computer program PANCOR to assess the interferences due to tunnel walls and model support in a slotted wind tunnel test section at subsonic speeds. Input data requirements are described in detail and program output and general program usage are described. The program is written for effective automatic vectorization on a CDC CYBER 200 class vector processing system.

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